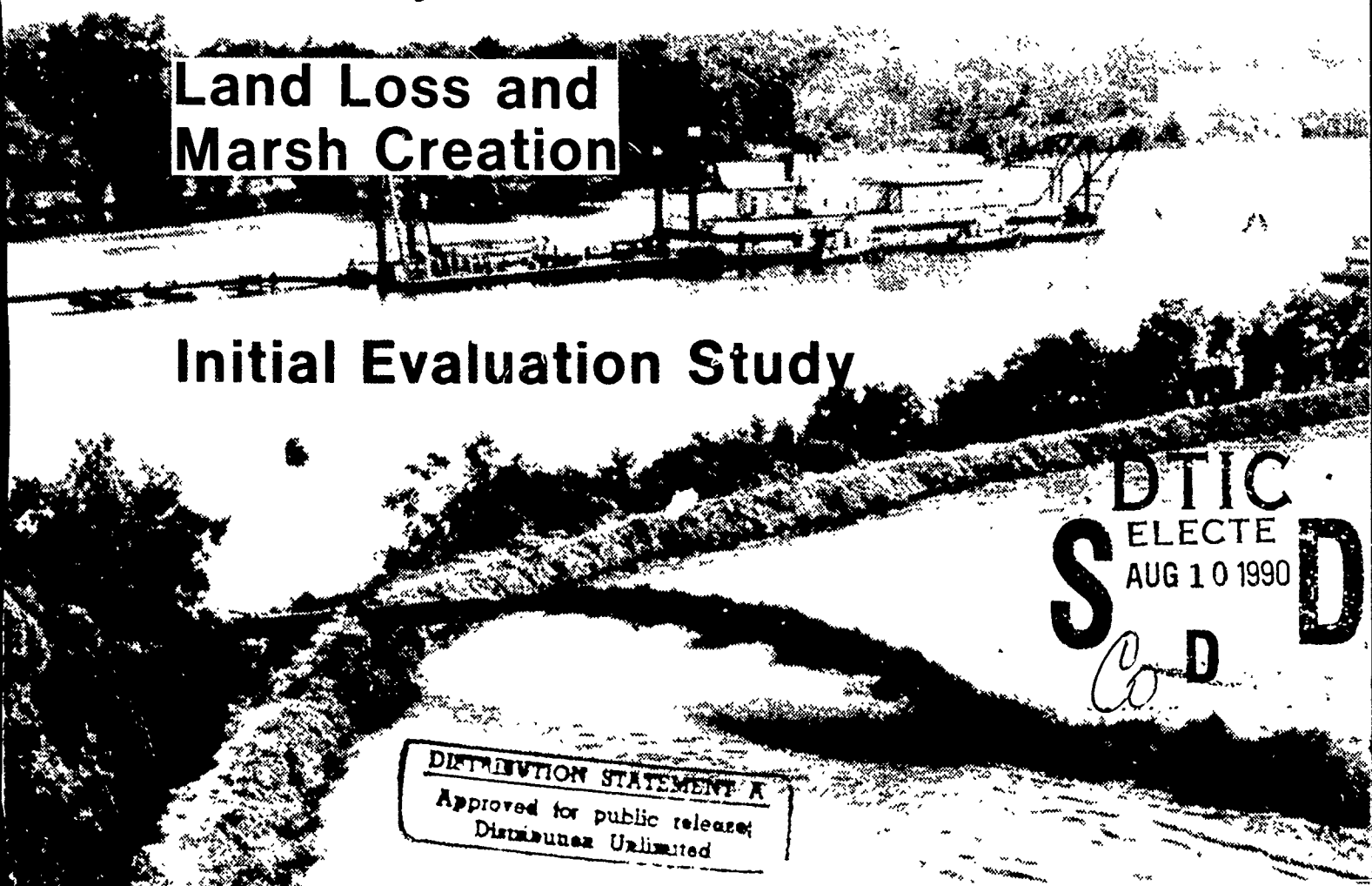
US Army Corps
of Engineers
New Orleans District

Louisiana Coastal Area, Louisiana

Land Loss and Marsh Creation

Initial Evaluation Study



November 1984

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REPLY TO
ATTENTION OF

LMNPD-P

November 1984

LOUISIANA COASTAL AREA, LOUISIANA

INITIAL EVALUATION REPORT

ON

LAND LOSS AND MARSH CREATION

SYLLABUS

Louisiana's coastal wetlands are highly prized for their biological productivity and their capacity to support diverse activities important to the nation and state. The wetlands constitute 41 percent of the coastal swamps and marshes in the continental United States. The marshlands support abundant fish and wildlife populations that annually supply 25 percent of the nations's fish harvest and 40 percent of its wild fur catch, and support about 25 million man-days of sport fishing and hunting each year. In 1983, the commercial and recreational fish and wildlife harvest were valued at $450 million. Beneath the marshes and offshore waters are extensive deposits of oil and gas that supply 22 percent of the nation's energy needs. In 1982, these resources were valued at $28 billion. The freshwater bodies in the marshes are major sources of water for coastal communities, industry, and agriculture.

To develop the wetlands resources and provide for the needs of the 2.1 million people who live, work, and play in the area, the nation and state have made a tremendous investment in the Mississippi delta region and throughout the coastal area. This investment has made enormous economic growth possible. But the growth has not been without consequences that threaten the use and enjoyment of the area.

The marshes are disappearing at the alarming rate of 39.6 square miles per year due to compaction, subsidence, sea level rise, erosion, saltwater intrusion, and man's activities. The land loss trend is expected to continue and, by the year 2040, about 1,000,000 acres of wetlands could disappear beneath the gulf. The gulf may advance inland as much as 33 miles and thus expose communities to hurricane-induced flooding. If nothing is done, the gradual loss of land could alter the very vitality of the wetlands and endanger the tremendous investment in the area. By the year 2040, losses to the wetlands, fish and wildlife, and development in the area could reach $600 million.

To find solutions to the land loss problem, a number of measures were evaluated including controlled and uncontrolled sediment diversions, placing dredged material, injecting liquids into subsurface strata, and regulating alteration of wetlands. An array of plans that include uncontrolled sediment diversion and dredged material from eight navigation channels appear to be economically justified and environmentally acceptable. Therefore, it is recommended that these plans be investigated in greater detail in a feasibility study. During the feasibility study, the other alternatives of controlled diversion and transporting material from the Mississippi River to nearby subsiding areas will also be analyzed in further detail.

Whether or not the plans are justified depends on the dollar value of the marsh. The value of the marsh as real estate and as a producer of commercial and recreational fish and wildlife has been determined, but this is only a portion of the true monetary value of the marsh. The marshes are also valued for their unique esthetic and ecologic characteristics and priceless cultural resources, as a repository for domestic and agricultural wastes, and for the capacity to buffer hurricane-induced flooding. Assigning a dollar value to these so-called "intangible benefits" is difficult. Therefore, it is also recommended that the intangible benefits of the marsh be investigated so that the true value can be used in determining the economic feasibility of an alternative plan.

Another significant problem is lack of data. Data on subsidence are sparse and substantially more are needed to project subsidence rates and relate them to erosion and flooding. More detailed analysis and verification of the land loss rates and shoreline changes are needed to predict future conditions in the coastal area. The hurricane flood threat should also be reanalyzed and possibly revised. Therefore, it is further recommended that this kind of information and analysis be undertaken to develop and justify solutions to the hurricane flooding problems in an initial evaluation study.

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INITIAL EVALUATION REPORT

ON

LAND LOSS AND MARSH CREATION

This report presents the findings of the initial evaluation study of plans to reduce land loss and create marsh in the coastal area of Louisiana. The coastal wetlands are being converted to open water at an alarming rate, a trend that is expected to continue. Continued land loss will cause serious economic and development problems for coastal communities, as well as a loss of fish and wildlife resources important to the state and nation.

STUDY AUTHORITY

Study of the Louisiana coastal area was authorized by resolutions of the Committees on Public Works of the U. S. Senate and House of Representatives. The Senate resolution was sponsored by Senator Russell B. Long and the late Senator Allen J. Ellender and adopted on 19 April 1967. The resolution reads:

> "RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, That the Board of Engineers for Rivers and Harbors created under Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby requested to review the reports of the Chief of Engineers on the Mermentau River and Tributaries and Gulf Intracoastal Waterway and connecting waters, Louisiana, published as Senate Document Numbered 231, Seventy-ninth Congress, on the Bayou Teche, Teche-Vermilion Waterway and Vermilion River, Louisiana, published as Senate Document Numbered 93, Seventy-seventh Congress, on the Calcasieu River salt water barrier, Louisiana, published as House Document Numbered 582, Eighty-seventh Congress, and on Bayous Terrehonne, Petit Caillou, Grand Caillou, DuLarge, and connecting channels, Louisiana, and the Atchafalaya River, Morgan City to the Gulf of Mexico, published as House Document Numbered 583, Eighty-seventh Congress, and other pertinent reports including that on Bayou Lafourche and Lafourche-Jump Waterway, Louisiana, published as House Document Numbered 112, Eighty-sixth Congress, with a view to determining the advisability of improvements or modifications to existing improvements in the coastal area of Louisiana in the interest of hurricane protection, prevention of salt water intrusion, preservation of fish and wildlife, prevention of erosion, and related resource purposes."

The House of Representatives Committee on Public Works adopted an identical resolution on 19 October 1967. Sponsors were U. S. Representatives Edwin W. Edwards, Speedy O. Long, John R. Rarick, Joe D. Waggoner, Edwin E. Willis, and the late F. Edward Hebert, Hale Boggs, and Otto E. Passman.

Preliminary investigations under the overall study identified land loss and habitat deterioration as major problems in the Louisiana coastal area. Federal, state, and local agencies expressed considerable interest in accelerating studies that involved solutions to the problem. The Louisiana Governor's Coastal Protection Task Force has recommended to the legislature several pilot projects to stabilize the shoreline and divert water and sediment to restore marshes, and a study to determine future coastal conditions.

STUDY PURPOSE AND SCOPE

The purpose of this study is two-fold: to determine the causes and extent of land loss in the coastal area, and to ascertain whether there are feasible measures that would reduce land loss and create marsh to improve habitat and the productivity of fish and wildlife resources and preserve the marsh's capacity to buffer hurricane tides. With these specific and limited purposes, the study responds to only a portion of the water and related land resources problems and opportunities in the Louisiana coastal area. This report is an interim response to the Louisiana Coastal Area Study authorization.

The study area encompasses all of coastal Louisiana between the Pearl River and the Sabine River, an area of about 9.9 million acres (see Figure 1). All lands that would be inundated by the Standard Project Hurricane (SPH) induced tidal flooding with all existing and authorized hurricane protection works in place, roughly the 5-foot contour, are included in the study area.

The coastal area consists of two distinct physiographic elements, the deltaic plain and the chenier plain. The deltaic plain extends from the Chandeleur Islands westward to Marsh Island and includes the active deltas of the Mississippi and Atchafalaya Rivers. The chenier plain is located west of Marsh Island. The area can be further subdivided into nine

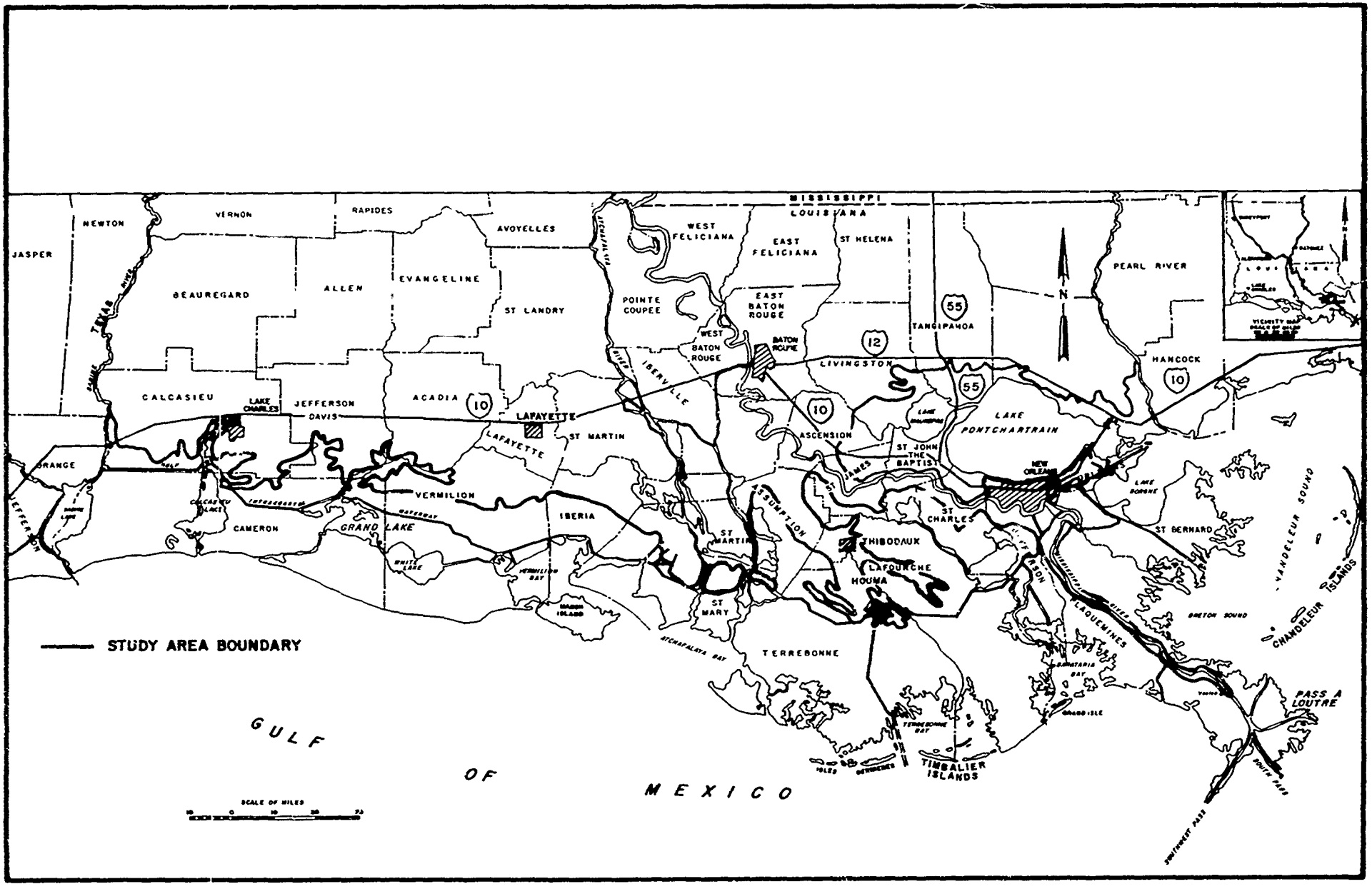


FIGURE 1. STUDY AREA.

sub-basins on the basis of hydrologic characteristics: Chandeleur Sound, Breton Sound, Mississippi River active delta, Barataria Bay, Terrebonne Bay, Atchafalaya Bay, Vermilion Bay, Grand and White Lakes, and Calcasieu Lake.

Twenty parishes are completely or partially in the study area: Ascension, Assumption, Calcasieu, Cameron, Jefferson, Jefferson Davis, Iberia, Lafourche, Livingston, Orleans, Plaquemines, St. Bernard, St. Charles, St. James, St. John the Baptist, St. Mary, St. Tammany, Tangipahoa, Terrebonne, and Vermilion Parishes, and are included in statistical data for population, employment, income, and recreational use. The New Orleans Metropolitan Statistical Area (MSA) is located in the study area, and the Baton Rouge, Houma-Thibodeaux, Lafayette, and Lake Charles MSA's border the area.

Study efforts for this report involved use of available data and information, aerial and ground reconnaissance of the area as needed, and office studies. The existing and projected 50-year environmental conditions related to land loss with and without Federal improvements were assessed. The problems and opportunities associated with land loss were assessed. The feasibility of engineering improvements was determined and social, cultural, economic, and environmental impacts were evaluated.

PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS

A number of studies and reports concerning water resources development in coastal Louisiana have been prepared by the U. S. Army Corps of Engineers (USACE), other Federal, state, and local agencies, research institutes, and individuals. These studies were an extensive data base for the interim report. The information was used to identify historical trends and existing conditions in the study area, to provide insight for projecting future conditions, and to assist in identifying problems.

Several Federal and non-Federal projects that influence water resources have been constructed in the area. The more relevant studies, reports, and projects are summarized in the following paragraphs.

Several broad scope studies were performed as part of the authorized Louisiana Coastal Area Study.

o The U. S. Fish and Wildlife Service (USFWS) conducted a statewide survey in 1970 to determine participation in fishing, hunting, and wildlife-oriented activities in the coastal area in the 1968-1969 season. The survey was conducted under contract to the USACE.

o The Louisiana Wildlife and Fisheries Commission and the Cooperative Wildlife Research Unit, Louisiana State University, with support from the USACE, investigated vegetation, water, and soil characteristics and conducted an inventory of wildlife in the coastal area. As a result of this effort, a vegetative type map of the Louisiana marshes and five reports were published, the last one in 1971.

o The National Marine Fisheries Service, under contract to the USACE, analyzed the relationship between commercial fish production and characteristics of the estuarine environment, and established resources and resource development needs related to estuarine ecology. The studies were completed in 1972.

o The Center for Wetland Resources, Louisiana State University, under contract to the USACE, performed studies of the hydrologic and geologic characteristics of coastal Louisiana. The studies examined and identified trends in the coastal area resulting from natural processes and human activities, identified significant environmental parameters, determined freshwater requirements to implement changes for fish and wildlife enhancement and for land building, and developed management and structural approaches to solving problems in the estuarine environment. The findings

and recommendations of the studies are contained in a series of 18 reports, the last one published in 1973.

o The USACE, in participation with an interagency group, conducted a fish and wildlife study of the coastal area and the Atchafalaya Basin Floodway in support of several ongoing studies, including the Louisiana Coastal Area Study. The fish and wildlife study incorporated information from the previous studies and included a preliminary determination of the cyclic quantities of supplemental fresh water needed to optimize productivity of fish and wildlife resources and the water and sediment requirements for land building, and the possible options for supplying this water to the estuarine areas.

o The USACE prepared a final feasibility report, "Louisiana Coastal Area, Freshwater Diversion to Barataria and Breton Sound Basins," in September 1984. The report recommends diverting Mississippi River water near Caernarvon into the Breton Sound Basin and near Davis Pond into the Barataria Basin to enhance habitat conditions and improve fish and wildlife resources. The report also recommends that the plan be implemented under the authorized Mississippi Delta Region Project, which is identical in purpose. The diversions would reduce land loss and save about 99,200 acres of marsh. The State has furnished letters of intent and has contributed $200,000 for advanced engineering and design studies for the Caernarvon structure. The structure is scheduled for construction in November 1986. The State of Louisiana and St. Charles Parish have furnished the necessary letters of intent for the Davis Pond site.

o The USACE prepared a final feasibility report and EIS, "Atchafalaya Basin Floodway System, Louisiana," in 1982. The report recommended a plan to satisfy the flood control needs of southeastern Louisiana and optimize the environmental protection of the lower Atchafalaya Basin Floodway. In February 1983, the Chief of Engineers recommended further studies of the Atchafalaya Bay-Terrebonne marsh complex. These and other

studies will analyze flooding problems north, east, and west of the floodway and techniques for managing the developing delta in Atchafalaya Bay that are consistent with environmental values. In the investigations, a computer model will be used to determine delta growth. Study results will be included in a final feasibility report, "Atchafalaya Basin Land and Water Resources, Louisiana," scheduled for completion in 1987.

o A report entitled "Louisiana-Texas Intracoastal Waterway, New Orleans, La. to Corpus Christi, Texas," was published as House Document No. 230, 76th Congress, 1st Session. The report and prior River and Harbor Acts provide for the construction of a 12- by 125-foot channel 384 miles long from the mouth of the Rigolets to the Sabine River. The project was authorized by the River and Harbor Act of 23 July 1942. The main stem of the project was completed in 1944. The River and Harbor Act of 23 October 1962 authorized enlargement of the channel reach between the Sabine and Atchafalaya Rivers to 16 feet by 200 feet; however, this modification has never been implemented and is currently under study.

o A report entitled "Mississippi River, Baton Rouge to the Gulf of Mexico, Louisiana," was published as House Document No. 215, 76th Congress, 1st Session. The report recommended a navigation channel 35 to 40 feet deep by 800 to 1,000 feet wide. Construction of the channel was completed in 1963. The General Design Memorandum Supplement No. 2, dated Apil 1984, provides for the restoration of deteriorated bank lines below Venice and Southwest Pass with hydraulic fill to reduce shoaling. Shoal material not needed for bank restoration would be used to create a minimum of 9,000 acres of marsh. Supplement No. 2 is currently under review by higher authority.

o A report entitled "Mississippi River-Gulf Outlet," was published as House Document No. 245, 82nd Congress, 1st Session. The report recommended an additional outlet, a 36- by 500-foot channel 76 miles long from New Orleans to the Gulf of Mexico. The improvements were authorized by the River and Harbor Act of 29 March 1956. Construction was completed in July 1963.

o A report entitled "Calcasieu River and Pass, Louisiana," was published as House Document No. 436, 86th Congress, 2nd Session. The report and prior River and Harbor Act authorized a 35- by 250-foot channel 36 miles long from the Lake Charles Harbor and Terminal District (including the Clooney Island Loop) to the Gulf of Mexico. The project was authorized by the River and Harbor Act of 14 July 1960. Work was completed in October 1968.

o A report entitled "Barataria Bay, Louisiana," was published as House Document No. 82, 85th Congress, 1st Session. The project provides for a 12- by 125-foot channel approximately 37 miles long from the Gulf Intracoastal Waterway (GIWW) to Grand Isle, Louisiana. These improvements were authorized by the River and Harbor Act of 3 July 1958. All work was completed in December 1967.

o A report entitled "New Orleans to Venice, Louisiana, Hurricane Protection," was published as House Document No. 550, 87th Congress, 2nd Session. The project provides hurricane protection to developed areas in Plaquemines Parish along the Mississippi River. The locally constructed back levee from City Price to Venice on the west bank would be enlarged and the existing levee from Phoenix to Bohemia on the east bank would be brought up to grade. Work on the features is underway. The General Design Memorandum Supplement No. 5, dated October 1983, provides for the creation of 297 acres of marsh in the Delta-Breton National Wildlife Refuge as mitigation for marsh loss caused by the levees. The supplement is under review and is scheduled for completion in December 1984.

o A report on the Mississippi River and Tributaries project published as House Document No. 308, 69th Congress, 1st Session, recommended construction of the Mississippi Delta Region project. The project provided for four salinity control structures to introduce fresh water into the delta region to enhance habitat conditions and improve fish and wildlife resources. These improvements were authorized by the Flood Control Act of

1965 but have not yet been constructed. The project was reevaluated under the Louisiana Coastal Area Study that reconfirmed the east bank Caernarvon site and recommended that the west bank site be moved upriver to Davis Pond. A post-authorization change notification report recommending these changes was submitted to MRCVP-G, by letter, file LMNPD-P, dated 1 November 1984, subject, "Mississippi Delta Region project."

o A Report entitled "Deep-Draft Access to the Ports of New Orleans Baton Rouge, Louisiana," was completed in 1981. The report recommended deepening the Mississippi River to a project depth of 55 feet from the Gulf of Mexico to the Ports of New Orleans and Baton Rouge. Dredged material would be placed in subsiding areas east and west of the river below Venice to create 11,600 acres of marsh over a 50-year period. The report is currently under review. The Board of Engineers for Rivers and Harbors approved the report in March 1982.

o A report entitled "New Orleans-Baton Rouge Metropolitan Area, Louisiana," was completed in 1981. The report contains a comprehensive plan for development and conservation of water and related land resources in a 21-parish area. The report includes 13 parishes in the current study and data was incorporated where appropriate.

o A feasibility report entitled "Mississippi and Louisiana Estuarine Areas" was completed in 1984. The report recommends the diversion of Mississippi River water into the Lake Pontchartrain Basin and Mississippi Sound to enhance habitat conditions and improve fish and wildlife resources. The final feasibility report and EIS was submitted to the Mississippi River Commission in May 1984.

o The USFWS sponsored an ecological characterization study of the Chenier Plain of Louisiana and Texas (Gosselink et al., 1979) and of the Mississippi Deltaic Plain of Louisiana and Mississippi (Bahr et al., 1983 and Costanza et al., 1983). Their studies describe the important biological, physical, and socioeconomic components and processes of the

chenier and deltaic plain regions. The reports discuss the causes and effects of land loss and management measures to reduce land loss in the 9.2 million acre area covered by the Louisiana Coastal Resources Program (LCRP). The LCRP inland boundary generally follows the GIWW west of the river and Interstate 12 east of the Mississippi River. The area west of the river and the portion east of the river that would be inundated by the SPH flood is included in the current study area. Thus, the chenier plain study area is similar to the current study area, but the deltaic plain study excludes some wetlands west of the river and includes some nonwetlands east of the river. However, the information in these reports has been widely accepted as the best available for characterizing the biological, physical, and socioeconomic parameters affecting the chenier and deltaic plain ecosystems. This information was used to establish existing conditions and historical trends, to forecast future conditions, and to formulate and evaluate alternative plans.

o The USFWS and the Louisiana Department of Natural Resources (LDNR) supported habitat mapping studies of the deltaic and chenier plains, respectively (Wicker et al., 1980 and 1981). The habitat types were interpreted from aerial photographs for the years 1955/1956 and 1978 and this information was depicted on U. S. Geological Survey quandrangle maps at a scale of 1:24,000. Each habitat type on the 1955/1956 and 1978 habitat maps was measured and compared to determine net changes. The area covered by the habitat maps coincides with the LCRP area, which differs significantly from the current study area. The habitat information is the best available and was used to establish existing conditions and historical trends and to forecast future conditions. However, the data were modified to include only lands that would be inundated by the SPH flood and some wetlands above the LCRP in the Barataria and Chandeleur Basins.

o The USFWS published the "Proceedings of the Conference on Coastal Erosion and Wetland Modification in Louisiana: Causes, Consequences, and Options," edited by D.F. Boesch (1982). The proceedings provide a current

compendium of information on the natural and man-induced causes of land loss, their impacts on natural resources production and man's use of the area, and possible means of reducing land loss. This information was used to identify problems and possible solutions, and to evaluate the impacts of land loss and the benefits to be derived from marsh creation in the current study.

o The LDNR published a report entitled "Recommendations for Freshwater Diversion to Louisiana Estuaries East of the Mississippi River" in June 1982. The report recommends that Mississippi River water be diverted to the Lake Pontchartrain Basin and Breton Sound Basin to improve production of fish and wildlife resources. The report parallels and confirms studies conducted by the USACE under the Louisiana Coastal Area and Mississippi and Louisiana Estuarine Areas Studies.

o The LDNR published a report entitled "Louisiana's Eroding Coastline: Recommendations for Protection" in June 1982. The report recognizes that future losses of coastal wetlands is unavoidable and will require either retreat of development from the coastal zone or increasingly greater levels of protection. Areas with initial erosion problems were identified and ranked according to severity. The report recommends development and implementation of a shoreline protection plan and proposes a number of pilot projects using water and sediment diversions, dredged material placement, and planting vegetation as a means to reduce erosion. A study to determine future coastal conditions, including changes in shoreline configuration and impacts on developed areas, is also recommended. Information on erosion and shoreline changes was used to define problem areas, to forecast future conditions, and to evaluate alternative plans.

o Plaquemines Parish Mosquito Control District prepared a "Management Plan for the Breton Sound Estuary" in January 1981. The plan proposes diversion of fresh water and sediment to reduce saltwater intrusion, enlarge nursery and harvesting areas, and reduce the rate of land loss.

o Local interests have constructed salinity control structures at Bayou Lamoque, Little Coquille, Bohemia, White's Ditch, and Violet to retard saltwater intrusion and improve production of fish and wildlife resources.

REPORT AND STUDY PROCESS

This initial evaluation report documents the results of the first phase of the planning process and serves as the primary management tool for the overall conduct of the study. Its major focus is identification and documentation of those water and related land resources problems and opportunities requiring further analysis during the study. It provides a discussion of the planning objectives and possible solutions identified by the study team and local interests. It includes an initial impact assessment and evaluation of possible solutions. The report concludes that more detailed studies are warranted and discusses the requirements for further studies.

The study was conducted in accordance with the U. S. Water Resources Council "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies."

PROBLEM IDENTIFICATION

NATIONAL OBJECTIVE

The national objective of Federal water resources planning is directed at achieving national economic development (NED), which is consistent with protecting the nation's environment in accord with national environmental statutes, applicable executive orders, and other Federal planning requirements, and is responsive to state and local concerns. The NED objective is achieved by increasing the value of the national output of

goods and services and reasonably maximizing net economic benefits. Benefits are maximized with due consideration for enhancing environmental quality, regional development, and social concerns.

During the study process, historical trends and existing conditions are used as a base for forecasting future conditions. In an assessment of the nature and extent of changing conditions, the problems and the opportunities for improving conditions are identified and the specific planning objectives defined. Management measures that address the objectives are evaluated and the most feasible measures are incorporated into an array of specific plans. The plans are then assessed and evaluated in terms of their engineering feasibility and their adverse and beneficial effects on the NED objective. The effects on environmental quality are also evaluated. Finally, the plans are compared to select those that warrant further detailed study.

EXISTING CONDITIONS

CLIMATE

The climate of coastal Louisiana is influenced by the warm waters of the Gulf of Mexico that moderate the air temperatures. The result is a humid, subtropical climate with mild winters and long, hot summers. The average annual temperature is 68° F.

Rainfall is abundant throughout the year and averages about 59.7 inches. Although the rainfall is high according to national averages, there are periods when the amount is below normal and is exceeded by water losses due to evaporation and transpiration. When rainfall is 10 percent below normal for several continuous months, a drought is said to exist. This condition occurs about 25 percent of the time. Rainfall shortages from 2 to 5 inches are estimated to occur more than 50 percent of the time.

The winds are predominantly from the northeast in the fall and winter, and from the southeast in the spring and summmer. The strongest winds are associated with the high pressure systems that penetrate the gulf area in winter and with hurricanes in summer. The winter storms have produced wind speeds up to 47 mph, and hurricanes have generated winds in excess of 190 mph in the area. Since 1893, a total of 75 tropical storms and hurricanes have struck the coast while another 103 passed offshore but affected the area.

LAND RESOURCES

The Mississippi River has had a profound effect on the landforms of coastal Louisiana. The entire area is the product of sediment deposition following the latest rise in sea level about 5,000 years ago. Sedimentation has caused the coastline to advance gulfward 15 to 50 miles since that time, forming the present day coastal plain. Based on the sedimentary processes responsible for formation of the surface features, the plain is divided into distinct physiographic areas: the deltaic plain and the chenier plain.

The deltaic plain was formed by direct deposition of the Mississippi River as it migrated back and forth across southeast Louisiana. During the past 5,000 years, the river shifted courses and formed seven major delta lobes that are discernible in the area. Figure 2 depicts the major delta lobes and their periods of activity, including the newly emerging Atchafalaya Delta. Each Mississippi River deltaic cycle was initiated by a break or crevasse in the river's natural levee system. Sediment deposition centered in the vicinity of the crevasse but extended gulfward to create a delta lobe. As the lobe expanded, the river's channel enlarged, bifurcated, and reunited to form a network of distributaries bordered by natural levees and interdistributary troughs. In the troughs, extensive swamps and marshes developed. Some distributaries were favored, while others were abandoned. After abandonment, the area underwent compaction, subsidence, erosion, and

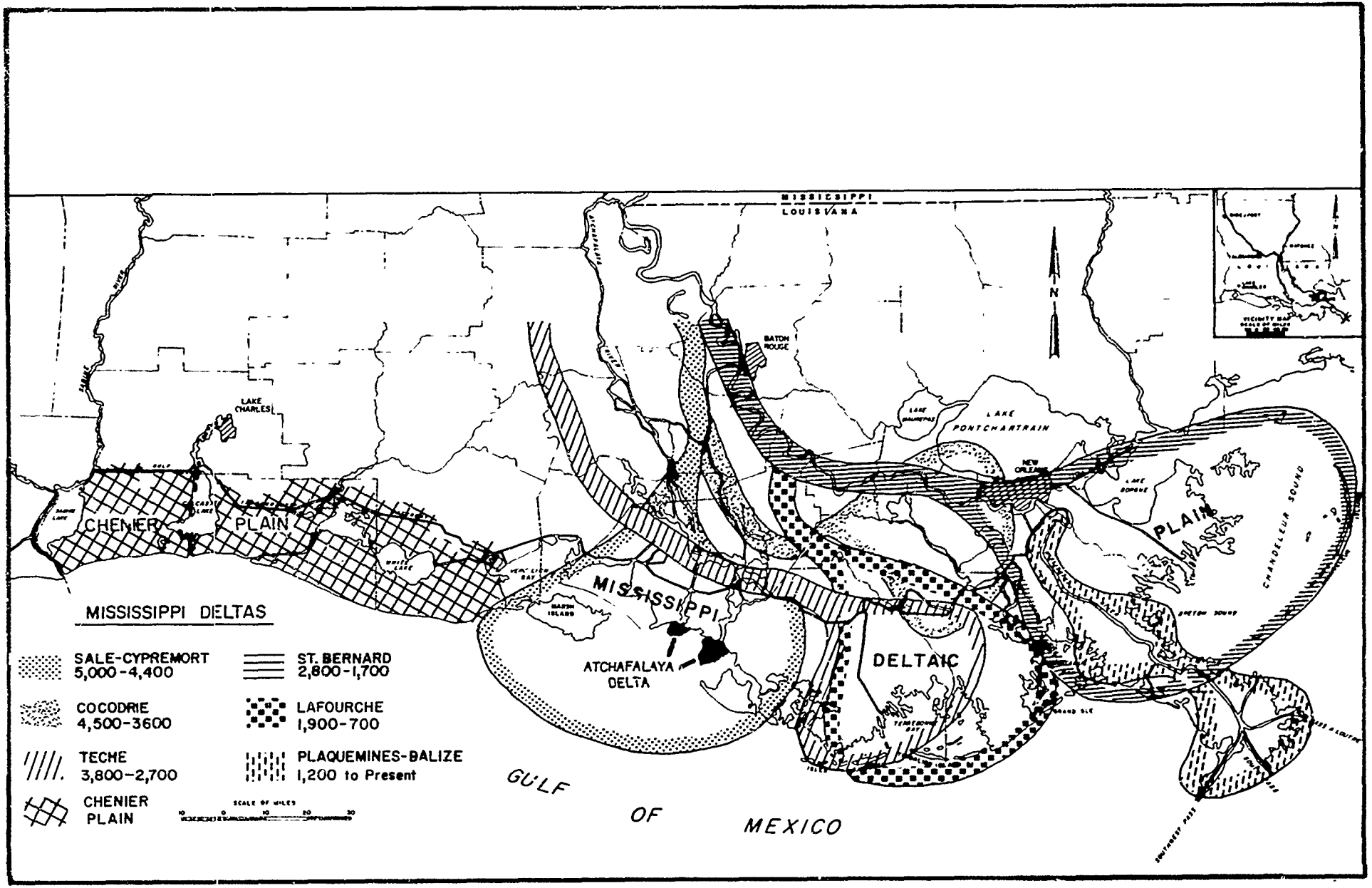


FIGURE 2. CHENIER PLAIN AND DELTAIC PLAIN.

marine inundation. The marshes became progressively more saline. Water bodies developed and the shoreline retreated rapidly. Gulf waves reworked the sediments along the margins of the deltas and redeposited the coarse materials to form the barrier islands.

The chenier plain developed as a result of sediments deposited by the prevailing east to west longshore currents in the gulf. The currents carried westward some of the sediments discharged by the Mississippi River into the gulf and desposited the sediments along the Vermilion and Cameron Parish coasts to form mudflats. The mudflats were colonized by marsh grasses that stabilized the flats and aided in sediment deposition. The mudflats continued to advance gulfward as long as sediments were furnished by the river. When sedimentation ceased, the waves attacked and reworked the marsh deposits. The coarse materials were redeposited as beaches overlying the marshes. The beaches continued to grow until sediments were sufficient to allow mudflat accretion. Mudflat development isolated and surrounded the recently formed beach. The tree-covered, stranded beaches are called cheniers. Some of the cheniers are nearly a mile across and 8 to 10 feet high. The oldest chenier is nearly 10 miles inland from the present shoreline.

Use of the 4,385,100 acres of land in the area is, to a large extent, determined by its nature. Wetlands constitute 72 percent of the land area and are characterized by low relief with an imperceptible slope towards the gulf. Standing significantly above the wetlands are the most prominent topographic features, the natural levees of the Mississippi River and the cheniers. Elevations vary from approximately 30 feet above National Geodetic Vertical Datum (NGVD) on the natural levees and 10 feet above NGVD on the cheniers to at or below NGVD in the wetlands. The natural levees and cheniers and, to a lesser extent, reclaimed wetlands adjacent to the elevated ridges are intensely developed. Developed lands comprise 18 percent of the land area and are distributed between urban-industrial (5.7 percent) and agricultural (12.3 percent). The remaining 10 percent of the

land area includes upland forest, scrub-shrub, beaches and dunes, and dredged material disposal areas.

Today, except for the formation of a delta in Atchafalaya Bay and mudflats along the Vermilion Parish coast, much of the coastal area is in various stages of deterioration due to compaction of sediments, subsidence, sea level rise, erosion, saltwater intrusion, and man's activities. Coastal Louisiana has subsided at a rate of 1.8 feet per century for the past 7,000 years (Penland and Boyd, 1983). Associated with subsidence is eustatic sea level rise that has been estimated at 0.4 feet per century (Nummedal, 1983). Subsidence and sea level rise intensify saltwater intrusion and erosion that also contribute to land loss.

Collectively, all these factors caused the shoreline to retreat at average rates of 9 to 62 feet per year between 1812 and 1954. The rates of shoreline retreat have accelerated in recent years. Figure 3 depicts shoreline changes for the periods 1812 to 1954 and 1955 to 1978. The rate of shoreline retreat is greatest along the barrier islands of the relatively young Lafourche Delta. The islands are migrating landward at rates up to 60 feet per year (Gagliano et al., 1982). The erosion is the result of a combination of wind and boat-generated waves, channelization, sediment depletion, and subsidence.

Another factor that has accelerated land loss is the construction of canals for navigation, drainage, and mineral exploration, and ponds for wildlife refuges and farms. Between the 1930's and 1960's, approximately 145,300 acres of lands were converted to canals and manmade ponds. During this period, the canals lengthened the tidal shoreline by 6,100 miles providing additional avenues for saltwater intrusion and accelerating erosion. By 1978, the canal area increased to 196,000 acres (Wicker et al., 1980 and 1981). The canal length increased to 8,200 miles.

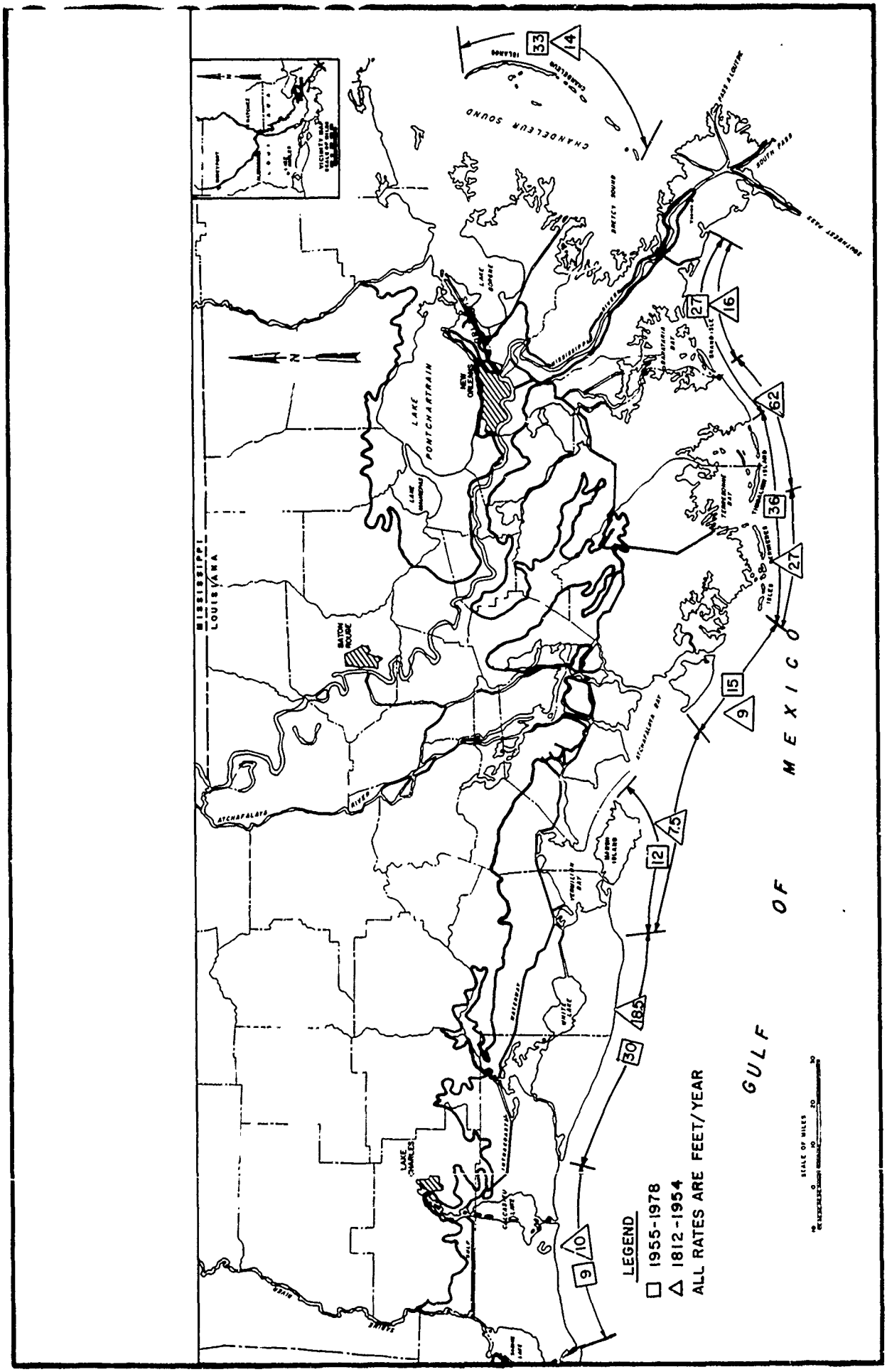


FIGURE 3. SHORELINE CHANGES 1812 to 1978.

The amount of land loss from all causes is impressive. About 800,000 acres of wetlands in the deltaic plain were converted to open water since 1900 with over half of the loss occurring since the mid-1950's (Gagliano, 1981).

Between 1955/1956 and 1978, approximately 557,700 acres of wetlands were lost to open water (Wicker et al., 1980 and 1981). By comparison, Chandeleur Sound is 578,000 acres. This represents a land loss rate of 25,350 acres per year or 39.6 square miles per year (mi^2/yr) which indicates that the rate has increased since the previous rate of 16.5 mi^2/yr.

Figure 4 depicts the land loss rates that were determined for most of the 7.5 minute quadrangle maps in the coastal area during the period 1955/1956 to 1978. The loss rate for the deltaic plain (28.5 mi^2/yr) is more than double the rate for the chenier plain (11.1 mi^2/yr). The highest rates occur in the modern delta, which has the maximum subsidence rate. This information indicates that between 1978 and 1990, an additional 229,900 acres of wetlands will be lost: 148,700 acres in the deltaic plain and 81,200 acres in the chenier plain.

WATER RESOURCES

The major sources of fresh water are the Mississippi River and its distributary, the Atchafalaya River, with average annual flows of 450,000 and 194,000 cubic feet per second (cfs), respectively. These flows represent approximately 90 percent of the fresh water passing through the coastal area. None of the fresh water reaches the marshes, however, since levee systems confine the flows. During an average flood season, the Mississippi and Atchafalaya Rivers carry in suspension approximately 166 and 110 million tons of sediment, respectively. The sediment load has decreased since the 1950's. The flood season usually begins in December, reaches a peak in April, and declines through July. The average monthly discharges and suspended sediment load during the flood season for the Mississippi and Atchafalaya Rivers from 1970 to 1981 are shown on page 22.

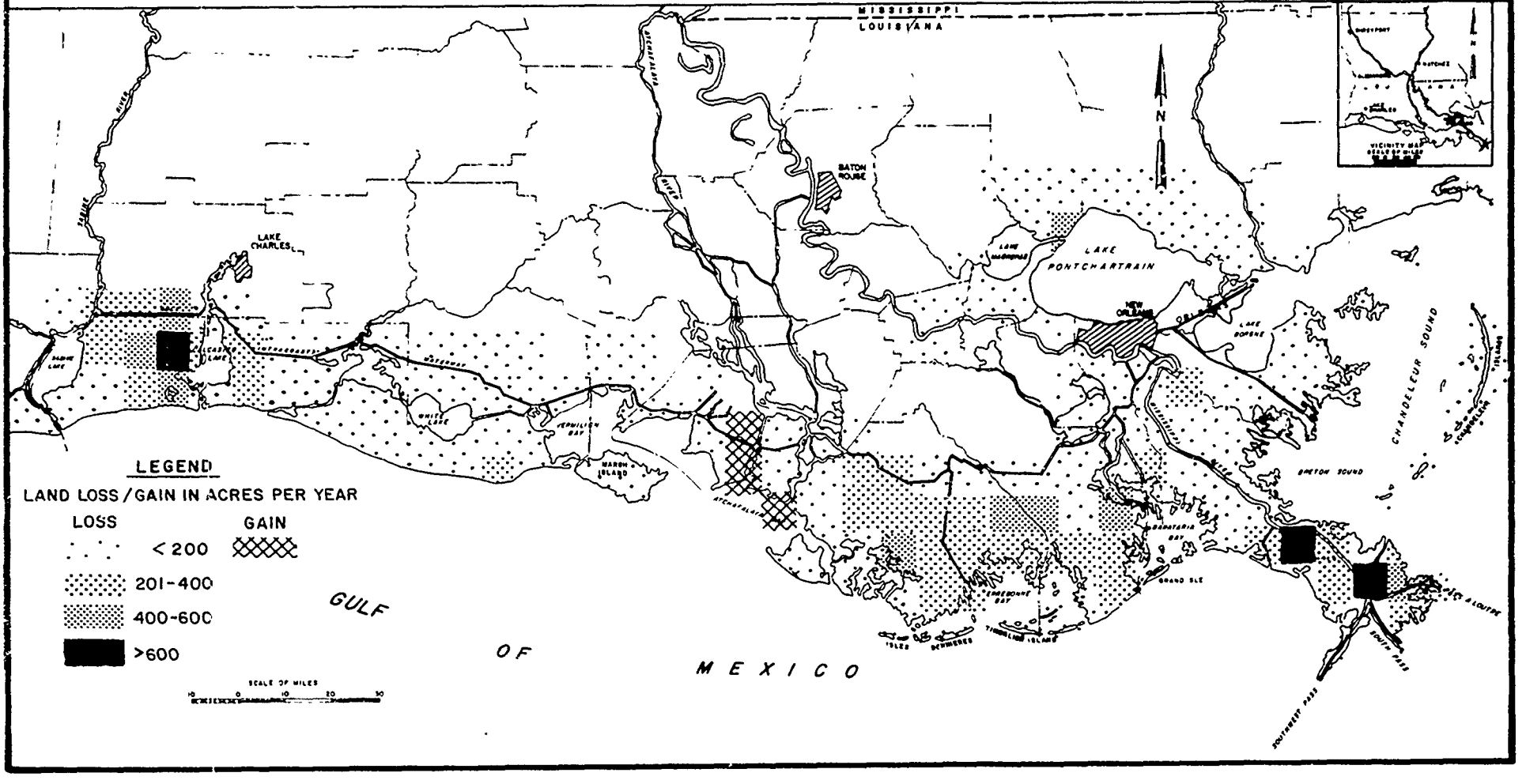


FIGURE 4. LAND LOSS RATES 1955 to 1978.

	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Mississippi River								
Flow (1,000 cfs)	482	547	542	685	785	733	550	375
Sediment (1,000 tons/day)	497	535	482	781	716	602	449	334
Atchafalaya River								
Flow (1,000 cfs)	223	256	257	328	385	361	275	189
Sediment (1,000 tons/day)	293	287	301	438	351	348	325	167

Small amounts of fresh water are contributed by the Pearl, Tangipahoa, Vermilion, Mermentau, and Calcasieu Rivers and Bayou Teche. The tidal portions of these streams are characterized by their meandering pattern and sluggish flows. Surface drainage is away from the natural levees into the wetlands. Drainage from leveed urban areas is evacuated by pumps to the adjacent wetlands. The water flows through a myriad of interconnected waterways, lakes, bays, and sounds to the Gulf of Mexico. The lakes, bays, and sounds constitute major features in the landscape and cover 55.8 percent of the area or 5.5 million acres. Nearly 89 percent of the estuarine water bodies are located in the deltaic plain. In 1978, there were an estimated 8,200 miles of manmade waterways that cover 196,000 acres and 30,800 acres of manmade lakes located primarily in wildlife refuges in the chenier plain.

The tides east of Atchafalaya Bay are mainly diurnal with one high and one low tide in a day. West of the bay, however, there are two high and two low tides in a day. The range of the tides near the coast is about 1.5 feet east of Atchafalaya Bay and 2.0 feet west of the bay. Tidal influences extend inland to the vicinity of Interstate 12 east of the Mississippi River and to Interstate 10 west of the river. At that latitude, the tidal range is about 0.3 feet. Winds frequently modify the height of the tides. Strong southerly winds frequently raise water levels

about 1 to 5 feet above normal, and hurricanes can produce tides in excess of 20 feet. Conversely, northerly winds blow water out of the estuaries, depressing water levels 1 to 3 feet below normal.

Water circulation is affected by gulf currents and the Mississippi River flows. East of the river, the littoral drift is north and east though Breton and Chandeleur Sounds. Immediately west of the river, the currents are northwest and north to the vicinity of Timbalier Island, and then recurve in clockwise fashion to the delta. West of the island, the drift parallels the shoreline westward.

Salinities in the estuaries range between 20 and 30 parts per thousand (ppt) near the gulf coastline and decrease gradually inland. The area has experienced a long-term rise in salinity levels. Increased salinity levels are readily detected by shifts in vegetative types. As salinities increase, plants with high salinity tolerance replace plants with low tolerance. Comparing marsh vegetation maps depicting 1945 and 1968 conditions indicates that the saline marshes moved inland in the deltaic plain an average of 2.1 miles. In contrast, the saline marsh experienced minor changes in the chenier plain. Comparing the 1968 marsh map with one prepared in 1978 revealed that the more saline vegetative type increased in area by 13.4 percent in the deltaic plain and by 14.7 percent in the chenier plain. Thus, saltwater intruded further inland during the 10-year interval.

Water quality in the area is affected by the inflow of effluents from municipalities and industries located along the principal rivers and bayous. Other sources of pollutants include urban storm water runoff, sewage from homes and camps, runoff from agricultural areas, and waste from water-oriented recreation and commercial vessels. These discharges are characterized by concentrations of pesticides, organic compounds, nutrients, heavy metals, fecal coliform bacteria, and low dissolved oxygen. Occasionally, state water quality standards or the U. S. Environmental Protection Agency water criteria recommended for freshwater

and marine aquatic life are exceeded. Water quality is poorest near major communities on the northern edge of the marshes, but it improves in the lower marshes. Table 1 shows the water quality designation and the major water quality parameters that occasionally cause problems in the area.

BIOLOGICAL RESOURCES

The area contains 41 percent of the nation's coastal wetlands. The major wetland habitat types are bottomland hardwoods, wooded swamps, and marshes. The bottomland hardwood forests are typically located along the natural levees that stand above the marshes and on the elevated portions of the flood plains. Portions of these forests are seasonally flooded. The wooded swamps are at lower elevations in the poorly drained flood plain areas. The swamps are flooded for much of the year and serve an important function by regulating the flow of fresh water to the marshes and estuaries. The marshes extend in coastwise bands that are subdivided into fresh, intermediate, brackish, and saline (Chabreck, 1972). Figure 5 depicts the marsh vegetative types. Located in and adjacent to the marshes are many fresh to saline water bodies. The acreage of habitat types by sub-basin are presented in Table 2. The wetlands and water bodies provide excellent habitat for abundant and diverse species of wildlife and fish.

The wildlife resources include mammals, birds, amphibians, and reptiles that support a variety of commercial and recreational activities. Commercially important mammals in the forested wetlands and marshes are the nutria, muskrat, mink, otter, bobcat, skunk, and raccoon that provide about 40 percent of the nation's wild fur harvest and make Louisiana the leading fur-producing area in North America (Lowery, 1974). The forested wetlands and marshes also provide habitat for large populations of white-tailed deer, rabbits, and squirrels. More than two-thirds of the Mississippi Flyway's waterfowl population including mallards, pintails, gadwalls, widgeons, lesser scaup, teal, snow geese, coots, gallinules, rails, snipe, and woodcock winter in the marshes, swamps, and bottomland hardwood forests

TABLE 1

WATER QUALITY DESIGNATION AND MAJOR WATER QUALITY PARAMETERS

Sub-basin	Water Quality Designation	Heavy Metals	Pesticides	Organics	Nutrients	Fecal Coliform Bacteria	Dissolved Oxygen	Saltwater Intrusion
Chandeleur & Breton Sounds	Primary & Secondary Contact Recreation, Fish and Wildlife				X	X	X	X
Mississippi River Delta	Secondary Contact Recreation, Fish and Wildlife	X	X	X		X		
Barataria Bay	Effluent Limited[1]/	X	X		X	X	X	X
Terrebonne Bay	Secondary Contact Recreation, Fish and Wildlife		X		X	X	X	X
Atchafalaya Bay	Secondary Contact Recreation, Fish and Wildlife				X		X	X
Vermilion Bay	Effluent Limited[1]/		X		X	X	X	X
Grand & White Lakes	Effluent Limited[1]/	X	X	X	X			X
Calcasieu Lake	Water Quality Limited[2]/	X	X	X	X	X	X	X

1/ Meets standards after application of effluent limitation required by the Clean Water Act.
2/ Does not meet standards after application of the effluent limitations required by the Clean Water Act.

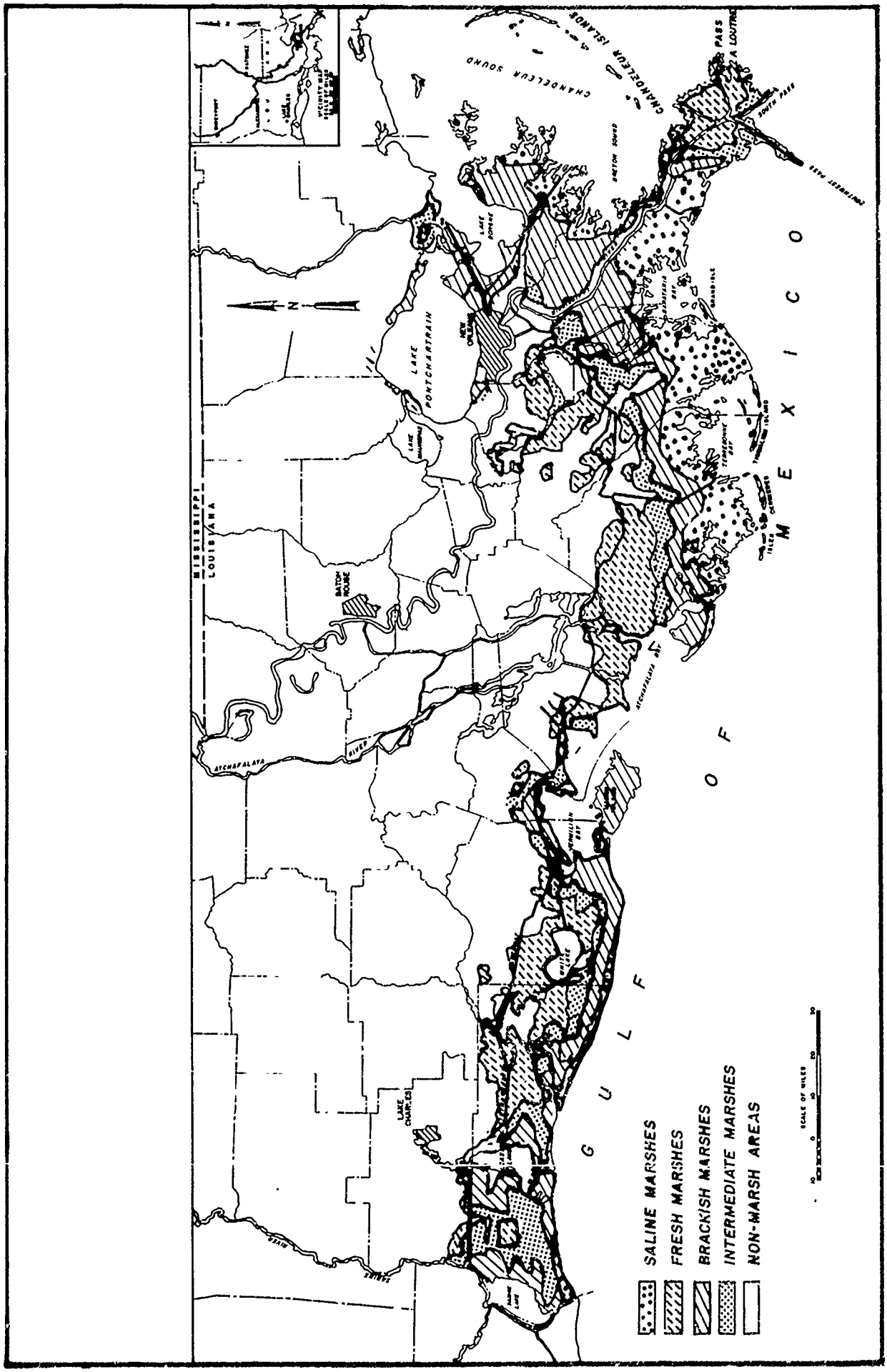


FIGURE 5. MARSH VEGETATIVE TYPES IN 1978.

TABLE 2

ACREAGE OF SELECTED WETLAND AND OPEN WATER HABITAT TYPES IN 1978

Habitat Types	Deltaic Plain							Chenier Plain	
	Chandeleur Sound	Breton Sound	Mississippi	Barataria	Terrebonne	Atchafalaya	Vermilion	Grand-White	Calcasieu
Forested Wetlands[1/]	215,900	10,500	9,900	218,900	66,600	46,700	65,800	3,100	[2/]
Marsh									
Fresh/Intermediate	58,300	13,600	66,200	196,600	239,500	58,900	92,100	316,200	141,900
Brackish	137,700	131,200	-	111,700	159,400	-	150,400	87,100	134,000
Saline	56,400	46,800	-	157,500	143,000	-	6,300	11,300	13,000
Subtotal	252,400	191,600	66,200	465,800	541,900	58,900	248,800	414,600	288,900
Beach & Dunes	2,400	[2/]	100	1,000	1,500	[2/]	500	700	1,300
Open Water									
Fresh	8,400	3,800	120,500	70,500	39,600	25,000	14,700	18,600	25,600
Estuarine	1,846,700	329,700	458,500	578,000	742,500	241,900	433,300	260,900	324,200
Subtotal	1,855,100	333,500	579,000	648,500	782,100	266,900	448,000	279,500	349,800
Total	2,325,800	535,600	655,200	1,334,200	1,392,100	372,500	763,100	697,900	640,000

SOURCE: Modified after Bahr et al. (1983) and Wicker et al. (1980 and 1981) to include 267,300 acres of wetlands and water bodies in the Chandeleur and Barataria Basins. Wicker also classified as agricultural, urban-industrial, upland forest, and dredged material disposal areas 292,700 acres in the deltaic plain and 362,500 acres in the chenier plain. About 55,900 acres in the current study area have not been classified.

[1/] Includes bottomland hardwoods, wooded swamp, scrub-shrub, and mangrove.
[2/] Less than 50 acres.

(Bellrose, 1976). These areas are also used by resident and migratory songbirds and raptors, while shorebirds, wading, and sea birds are abundant along marsh shorelines, beaches, and on the barrier islands. Amphibians are generally restricted to the fresh marshes, ponds, and forested wetlands. The bullfrog and pig frog are important from a commercial and sporting standpoint. Commercially important reptiles occurring in the marshes and swamps include the American alligator, common snapping turtle, and diamondback terrapin. The American alligator is abundant in the swamps and fresh/intermediate marshes and is harvested for its hide and meat. Sea turtles such as the loggerhead, Kemp's Ridley, hawksbill, leatherback, and green turtle occasionally occur in the saline waters in or adjacent to the area.

The fresh and estuarine water bodies support diverse and abundant finfish and shellfish populations that are exploited by commercial and recreational fishermen. The important fish species are estuarine-dependent, i.e., they spawn offshore in water with stable salinity and temperature but the young require the fertile, low salinity estuaries and marshes for the successful completion of their life cycle. These species account for over 95 percent of the commercial fisheries harvest that includes brown and white shrimp, menhaden, oysters, blue crab, Atlantic croaker, spotted and sand seatrout, spot, and red drum. Many of these species are also sought by sport fishermen.

The fresh and low salinity water bodies support large populations of finfish and shellfish. The important commercial species are red swamp crawfish, various species of catfish and bullheads, gars, bowfin, carp, freshwater drum, buffalo, and shad. The primary sport species include largemouth bass, black crappie, white crappie, bluegill, and catfish. The water bodies also support rich populations of phytoplankton, zooplankton, benthos, macroinvertebrates, and numerous small fishes. These organisms are vital components of the aquatic food chain.

A number of endangered and threatened species including reptiles, birds, and mammals are actually or potentially present in the area. The alligator is classified as "threatened" under the Similarity of Appearance clause of the Endangered Species Act of 1973. Under this classification, controlled harvest of this species is permitted. Endangered sea turtles occasionally present in the area include the Kemp's Ridley, hawksbill, and leatherback. The loggerhead and green sea turtles are also found in the area and are considered threatened. Endangered birds known to occur in the area include the bald eagle, brown pelican, arctic peregrine falcon, and red-cockaded woodpecker. Endangered birds that could possibly occur in the area include Bachman's warbler, Eskimo curlew, greater prairie chicken, whooping crane, and ivory-billed woodpecker. The Florida panther and red wolf may occur in the area. Endangered marine mammals that may venture into the nearshore waters of the area include blue, finback, humpback, sei, and sperm whales.

CULTURAL RESOURCES

The coastal area is rich in both prehistoric and historic cultural resources. The deltaic plain contains the highest density of archeological remains in the state. Almost all abandoned natural levees in the deltaic plain contain prehistoric or historic archeological sites. Due to favorable environmental conditions, many prehistoric sites were repeatedly reoccupied over long periods of time. Continuous occupation combined with high subsidence rates has produced an "iceberg" effect and only 1 or 2 feet of a site will be exposed while another 6 to 18 feet is buried below the ground surface as a result of subsidence. There is a high potential for archeological sites in this region as a result of burial and unique conditions that favor the preservation of wood, plant remains, fabrics, basketry, and other normally perishable remains. To date, over 800 sites have been recorded in this area. Since systematic archeological surveys are incomplete and many sites are buried below the marsh surface, the actual number of sites is probably much greater, although some recorded sites have been destroyed by erosion. Sites range in cultural associations

from 1,000 years B.C. to the historic period, but the majority date from the Coles Creek Period. The Louisiana Division of Archaeology lists 13 sites on the National Register. An additional 12 sites have been determined eligible for the register.

The chenier plain has a unique cultural history that combines Texas coastal elements with cultures of the Mississippi Valley. Sites ranging from Paleo-Indian (ca. 10,000 B.C.) to the historic have been identifed. Sites are found on the cheniers, natural levee crests, salt domes, and terrace margins. Over 400 sites have been recorded with the majority from the Coles Creek Period. To date, no archeological sites are listed on the National Register, but four sites have been determined eligible.

RECREATIONAL RESOURCES

The coastal lakes, bays, marshes, beaches, and the Gulf of Mexico provide a large, year-round resource base that supports a variety of recreational pursuits. The scenic land and shorefront areas support many land- and water-based activities that serve local recreationists and attract multitudes of tourists to the area. Table 3 lists the wildlife refuges and management areas.

The major recreational activities in both urban and rural areas include fishing, hunting, boating, water-skiing, swimming, sailing, picnicking, camping, walking for pleasure, sightseeing, and observing wildlife. An inventory of the major outdoor recreation facilities indicates that there are 368 boat launching ramps, 1,878 picnic tables, 1,845 recreational vehicle camping spaces, and 621 tent camping spaces. Commercial fishermen and trappers also use the resources of the area. While not a major impediment to recreation, these activities do compete with recreation and further limit the potential.

Fishing is by far the most popular activity with 234,200 resident sport fishing licenses issued in the 1982-1983 season. A license is not required

TABLE 3

WILDLIFE REFUGES (WR) AND MANAGEMENT AREAS (WMA)

Name	Parish	Activities			
		Hunting	Fishing	Boating	Camping
Breton Island National WR	Cameron		X		
Delta National WR	Plaquemines		X		
Lacassine National WR	Cameron	X	X		
Sabine National WR	Cameron	X	X		
Shell Keys National WR	Iberia				
Russell Sage State WR	Iberia		X		
Paul J. Rainey State WR	Vermilion		X		
Louisiana State WR	Vermilion		X		
Rockefeller State WR	Cameron		X		
St. Tammany State WR	St. Tammany		X		
Pearl River WMA	St. Tammany	X	X	X	X
Biloxi WMA	St. Bernard	X	X		
Manchac WMA	St. John the Baptist	X	X	X	
Bonnet Carre' WMA	St. Charles	X	X	X	X
Bohemia WMA	Plaquemines	X	X		
Pass a Loutre	Plaquemines	X	X		
Salvador WMA	St. Charles	X	X		
Wisner WMA	Lafourche	X	X	X	
Pointe-au-Chien WMA	Lafourche	X	X		
Attakapas WMA	St. Mary	X	X		
Atchafalaya Delta WMA	St. Mary	X	X		

for fishing with a rod, pole, or hook and line without a reel or artificial bait. The 1980 Louisiana Statewide Comprehensive Outdoor Recreation Plan Demand Survey indicated that boat fishing is the second most preferred activity of recreationists. The popularity is reflected in the 145,468 motorboat registrations issued in 1983, which is 48 percent of the state's total. Both fresh and saltwater fishing are popular. Neither type dominates the total fishing use and common launch areas are often used for both types.

Hunting is very popular. Small game hunting is the most prevalent activity with a wide range of species available. Big game hunting for white-tailed deer occurs in the more productive habitats such as bottomland hardwoods. Waterfowl hunting is the most well-known hunting activity in the area although its demand is lower than other hunting activities. For the 1982-83 hunting season, 205,900 resident hunting licenses were issued in the area. This figure includes 55,493 licenses issued for big game species.

A new pattern of recreational land use has evolved around the construction of recreational dwellings in the coastal marsh and on inland lakes and bayous. This phenomenon of camp construction increased significantly in the 1970's and today there are approximately 10,220 of these camps in the coastal area (Figure 6). The camps are built in many different styles and designs and vary from simple one-room unit construction to elaborate two-story units with such amenities as swimming pools, glass enclosed verandas, and accomodations for as many as 50 individuals at one time. More than 40 percent of the residential dwellings are only accessible by water. The camps are basically designed and used to accomodate one or more of three major recreation activities: hunting, fishing/boating, and, to a lesser extent, trapping. All marsh camps are multi-functional but the trapping camps, unlike the others, serve income as well as leisure-oriented activities and are considered to be support facilities for commercial activites. Much of the recreation activity supported by the camps occurs

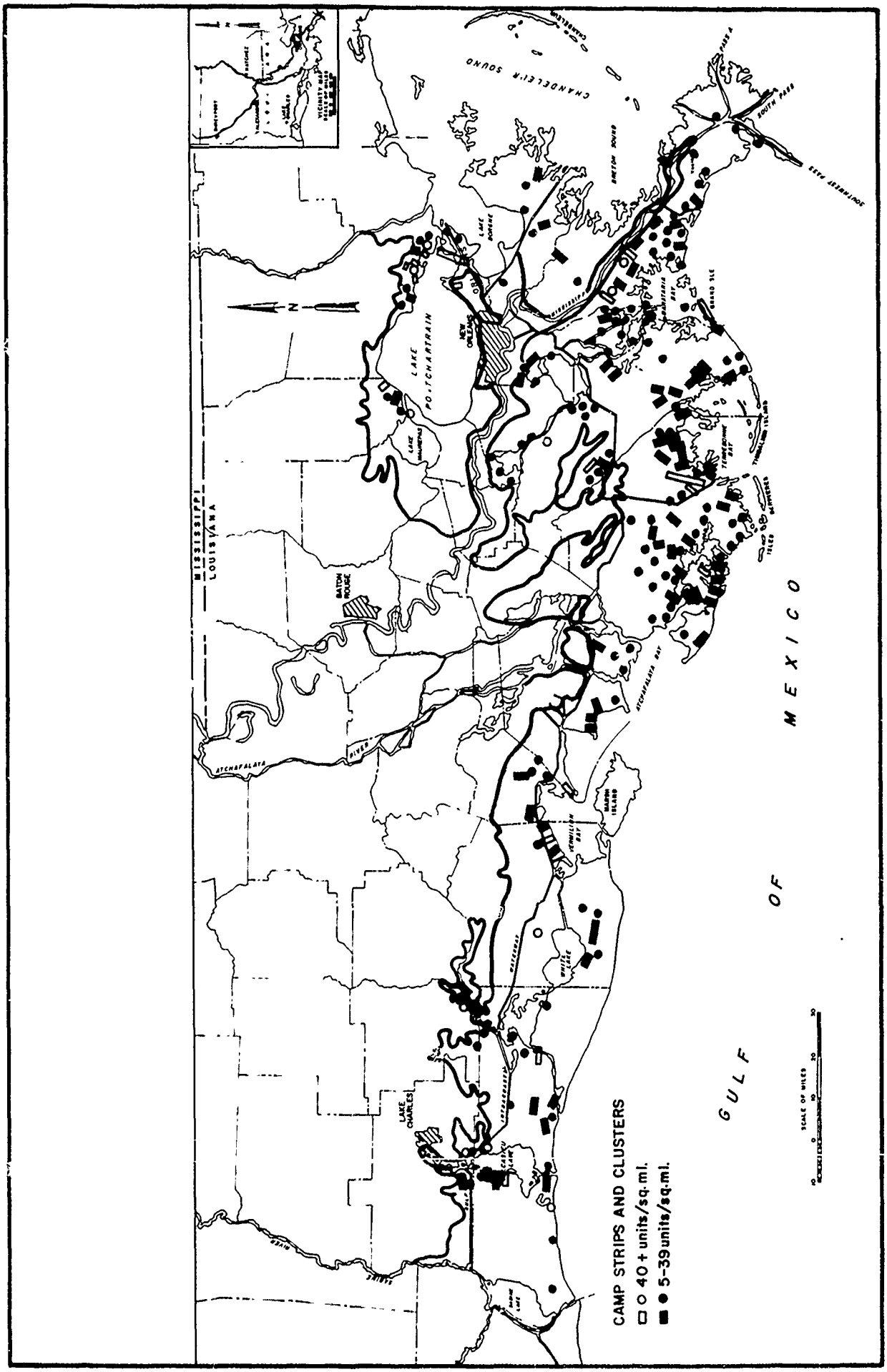


FIGURE 6. RECREATIONAL CAMPS.

on lands leased by the camp dweller from private landowners or land companies. Less frequently, the lease agreement is between the landowner and a hunting club that sponsors a limited membership to its dues-paying members. In 1976, a use survey was conducted of 88 camps along Bayou de Cade in south-central Terrebonne Parish. The results showed that these camps sustained nearly 30,000 man-days of recreational use annually. Applying these results to all 10,220 camps indicates the amount of recreation these dwellings will support.

Overall, the primary users of the recreation resources of the study area are residents of southern Louisiana, southern Mississippi, and eastern Texas. The 1980 survey conducted by the Louisiana Department of Culture, Recreation and Tourism, indicates that 81.7 percent of boat fishing activity occasions and 86.6 percent of the small game hunting activity occasions occur within 45 miles of the participant's residence.

HUMAN RESOURCES

The 1980 population of the area was 2,077,934, an increase of 16 percent from 1970. The annual growth rate exceeded both the national and state growth rates. During the 1970's, all urbanized parishes gained in population except Orleans Parish, which experienced net emigration. About 60 percent of the population is concentrated in the New Orleans MSA that includes Jefferson, Orleans, St. Bernard, St. Charles, St. John the Baptist and St. Tammany Parishes.

The 1981 per capita personal income for the area averaged $5,311. Ten parishes had per capita personal incomes above the state average. More notably, a majority of the parishes had higher per capita income growth rates than the state average. The growth in income and population reflects the expanding coastal Louisiana petroleum industry and the related service industries. Employment was about 839,000 persons in 1980, an increase of approximately 41 percent since 1970. The largest source of jobs was the

service sector with nearly 233,300 persons employed. Second in employment was the wholesale and retail trade sector (180,300). Other primary occupations in order of employment are manufacturing, transportation and public utilities, construction, finance and real estate, mining, government, agriculture, forestry, and fisheries and wildlife.

Employment data for fish and wildlife industries are sketchy. The Louisiana Department of Wildlife and Fisheries 1978 records indicate that 32,731 licenses were sold to full- and part-time commercial fishermen, sport fishermen who use commercial gear, wholesale and retail fish and shellfish dealers, trappers, and fur buyers. Over 91 percent of all licenses were for shrimping in the area in 1978. The number of licenses increased by 37 percent to 44,972 in 1982. The Louisiana State University Sea Grant program (Aquanotes, March 1983) indicates that in 1980 about 35,000 people were engaged in fishing yearly and approximately 80 percent of them participate in shrimping. Louisiana has a seasonal employment of 4,228 people in 117 fish processing plants and 580 people in 121 wholesale plants.

ECONOMY

The area has abundant commercially important minerals and a variety of fish and wildlife resources. The strategic location of the area and the numerous navigable waterways make the area a hub for foreign and domestic trade. The cultural and historical heritage of the area ranks with the most significant in the nation.

Commercially important minerals include crude petroleum, natural gas, sulfur, salt, lime, clay, sand, and gravel. In 1975, mineral production was valued at $7.4 billion, which represented 12 percent of the nation's mineral production. In 1982, the coastal area and offshore waters produced approximately 13 percent of the nation's crude petroleum and 31 percent of the natural gas, which were valued at $27.8 billion. Production from

offshore waters is carried by numerous pipelines through the estuaries and wetlands to refineries in or adjacent to the area. Sulfur, salt, and shell are also abundant.

Other important commercial activities center around the fish and wildlife resources. The coastal wetlands supply 25 percent of the nation's commercial fish harvest and 40 percent of the wild fur catch. In 1982, the coastal fisheries ranked first among the 50 states in total volume of fish and shellfish landings with 1.70 billion pounds and ranked third in value of landings at $240 million. These numbers do not include the unreported fisheries harvest. Adjusting the inshore shrimp and oyster harvest to reflect unreported landings, the 1982 harvest was 1.75 billion pounds valued at $310 million. The average yearly adjusted harvest of estuarine-dependent fisheries for the 1963-1978 period was 1.2 billion pounds with an average annual value of $308 million.

Important species include shrimp, oyster, and menhaden. Combined, these species account for 96 percent of the harvest and 97 percent of the value. Table 4 presents the average annual commercial harvest and value of major estuarine-dependent fisheries. The adjusted shrimp and oyster harvest indicates that Louisiana supplied 35 and 39 percent of the nation's shrimp and oyster harvest, respectively. The fishery resources support a host of related industries including canning, shipping, wholesaling and retailing, and restaurants, as well as building, selling, servicing boats and fishing gear, ice making, and commercial marinas.

Commercial wildlife activities are associated mainly with alligators and furbearers. About 15,200 alligators worth $2,730,000 were taken annually from 1979-1982. During the period 1978-1982, an average of 2.1 million furbearers were caught annually; the pelts and meats were valued at $13.8 million annually.

TABLE 4

AVERAGE ANNUAL COMMERCIAL HARVEST AND VALUE OF
MAJOR ESTUARINE-DEPENDENT FISHERIES

Species	Deltaic Plain	Chenier Plain	Total
		(Millions)	
Menhaden			
pounds	737.80	217.50	955.30
value ($)	$ 30.00	$ 8.85	$ 38.85
Shrimp			
pounds	74.36	7.31	81.67
adjusted[1]/	139.05	13.67	152.72
value ($)	$192.07	$ 18.88	$210.95
Oyster			
pounds	10.70	0.13	10.83
adjusted[2]/	26.75	0.32	27.07
value ($)	$ 41.04	$ 0.49	$ 41.53
Blue Crab			
pounds	12.00	1.06	13.06
value ($)	$ 3.26	$ 0.29	$ 3.55
Other Fish[3]/			
pounds	30.26	3.36	33.62
value ($)	$ 11.50	$ 1.27	$ 12.77
Total			
pounds	945.86	235 91	1,181.77
value ($)	$277.87	$ 29.78	$307.65

SOURCE: U. S. Department of Commerce, National Marine Fisheries Service. General canvas catch by water body and species for the years 1963-1978. Value represents an average of 1980-1982 exvessel prices.

1/ Reflects 200-percent increase in inshore landings based on surveys conducted by Louisiana Department of Wildlife and Fisheries (G.J. White, letter dated April 23, 1979).
2/ Reflects 150-percent increase in reported landings based on Markin and Hopkins (1962) and Lindall et al. (1972).
3/ Includes Atlantic croaker, seatrout, spot and red drum.

The sport fish and wildlife resources in 1978 provided an estimated 25.3 million man-days of recreation valued at $126 million. The most popular activities were freshwater and saltwater fishing and sport hunting. Waterfowl hunters spend an estimated $25 million annually (Louisiana Department of Wildlife and Fisheries, 1980).

In rural areas, commercial fishing, trapping, and agriculture make important contributions to the local economy. Major crops are rice, soybeans, sugarcane, and citrus fruits. Cattle are grazed in many parts of the marshes. In 1978, the market value of all agricultural products sold was $321 million, about 26 percent of the state total.

TRANSPORTATION

Shipping is a major industry. Deep-draft navigation has access to the Ports of New Orleans, Baton Rouge, Morgan City, and Lake Charles. The Port of New Orleans is the world's largest grain port, the largest seaport in the United States, and the second largest in the world in terms of waterborne tonnage handled. The Ports of Baton Rouge and Lake Charles border the study area, but deep-draft traffic must move through the area to reach these ports. The Ports of Houma and Morgan City are considerably smaller, but they make a sizeable contribution to the local economy. Shallow draft access is provided by many inland waterways including the GIWW, Barataria Bay Waterway, Bayou Lafouche, Houma Navigation Canal, Vermilion River, and the Mermentau River.

The major transportation routes are Interstates 10 and 12 and U.S. Highway 90, the primary east-west arteries. The Southern Pacific Railroad traverses much of the area. Spur lines extend along the alluvial ridges as far south as the GIWW and along the Mississippi River below New Orleans.

Pipelines are the primary carriers of petroleum products. Over 14,000 miles of onshore and 2,000 miles of offshore pipelines traverse the area. Louisiana Offshore Oil Port, Inc., began operations in 1981. This $700

million superport for imported oil was built 18 miles off Grand Isle by a consortium of oil companies. Massive pipelines move the oil from the port to the shore and into storage caverns in the Clovelly salt dome at Galliano, Louisiana. Oil is then moved from the salt caverns into one of seven pipelines serving individual oil company refineries along the gulf coast and in the Midwest.

FUTURE CONDITIONS

The most probable future conditions if no Federal action is taken are determined by establishing historical trends and existing conditions and projecting those conditions that are reasonably expected to prevail in the study area over the planning period 1990 to 2040. All authorized projects are considered in place including the Mississippi Delta Region project, which will reduce land loss in the Barataria and Breton Sound Basins, the New Orleans to Venice Hurricane Protection project, and the Mississippi River, Baton Rouge to the Gulf of Mexico project, which will create marsh with dredged material on the east and west banks of the river. The 16- by 150-foot channel authorized for the GIWW, Louisiana Section, was not considered in place.

LAND RESOURCES

The wetlands are projected to change in diversity and decrease in areal extent by 26.6 percent or 786,200 acres by the year 2040. About 554,300 acres in the deltaic plain and 231,900 acres in the chenier plain will be lost to open water. Table 5 presents the projected habitat changes in the deltaic and chenier plain regions. The loss of wetlands is due in part to anticipated land subsidence and sea level rise that could cause a net change in the relative land and water surface elevations of about 1.1 feet over the next 50 years. These changes will accelerate erosion. The combined effects of all factors will enable the gulf shoreline to advance inland nearly 33 miles in the deltaic plain and 2 miles in the chenier

TABLE 5

PROJECTED HABITAT CHANGES IN DELTAIC AND CHENIER PLAIN REGIONS

Region/ Habitat Type	1978	1990	2000	2020	2040
			Thousands of Acres		
Deltaic Plain/					
Forested Wetlands	634.3	599.4	566.5	509.9	451.8
Marsh					
Fresh/Intermediate	725.2	693.8	690.8	646.0	609.4
Brackish	690.4	670.4	625.1	526.8	459.7
Saline	410.0	352.9	310.4	272.6	241.3
Total Marsh	1,825.6	1,717.1	1,626.3	1,445.4	1,310.4
Open Water	4,913.1	5,056.5	5,180.2	5,417.7	5,610.8
Total Deltaic Plain	7,373.0	7,373.0	7,373.0	7,373.0	7,373.0
Chenier Plain/					
Forested Wetlands	3.1	2.9	2.8	2.6	2.4
Marsh					
Fresh/Intermediate	458.1	404.3	365.9	303.0	254.0
Brackish	221.1	195.5	176.7	145.0	119.5
Saline	24.3	22.7	21.5	19.4	17.6
Total Marsh	703.5	622.5	564.1	467.4	391.1
Open Water	629.3	710.5	769.0	865.9	942.4
Total Chenier Plain	1,335.9	1,335.9	1,335.9	1,335.9	1,335.9
Total Deltaic and Chenier Plain Regions	8,708.9	8,708.9	8,708.9	8,708.9	8,708.9

SOURCE: Modified after Wicker et al. (1980 and 1981) to include 267,300 acres of wetlands and water bodies in the Chandeleur and Barataria Basins.

plain. Inland areas will break up and be converted to open water. Figure 7 depicts the projected land changes and the future shoreline in 2040. The land loss and shoreline retreat will make the lands in and immediately adjacent to the study area more susceptible to flooding. The exact increase in frequency and height of flooding has not been determined.

The only area of major accretion is in Atchafalaya Bay where the Atchafalaya River is building a delta. During the 1973-1975 high water years, about 8,300 acres of delta emerged. By 2030, the delta is expected to be 192,000 acres. Figure 8 depicts the anticipated growth of the Atchafalaya River delta. Some of the sediments are being carried westward and deposited along the Vermilion Parish coast to form mudflats. The mudflats will grow rapidly as the Atchafalaya delta builds out and more sediments are carried westward and deposited along the Vermilion Parish coast.

WATER RESOURCES

Water bodies are projected to increase in area by about 13.5 percent or approximately 786,200 acres by the year 2040. The increase in water area is due in part to an anticipated general rise in sea level and subsidence of the land that could produce a net change in land and water surface elevations of about 1.1 feet over the next 50 years. The increase in water levels will enlarge the land/water interface and accelerate saltwater intrusion. The average salinities are expected to increase; the 5 and 15 ppt isohalines will move inland as much as 2 miles from their respective 1990 positions as shown in Figure 9.

Water quality is expected to deteriorate in the forseeable future with continued saltwater intrusion, urbanization, drainage improvements, and loss of wetlands. Saltwater will intrude into many coastal streams with greater frequency and duration, making these streams unsuitable as a water

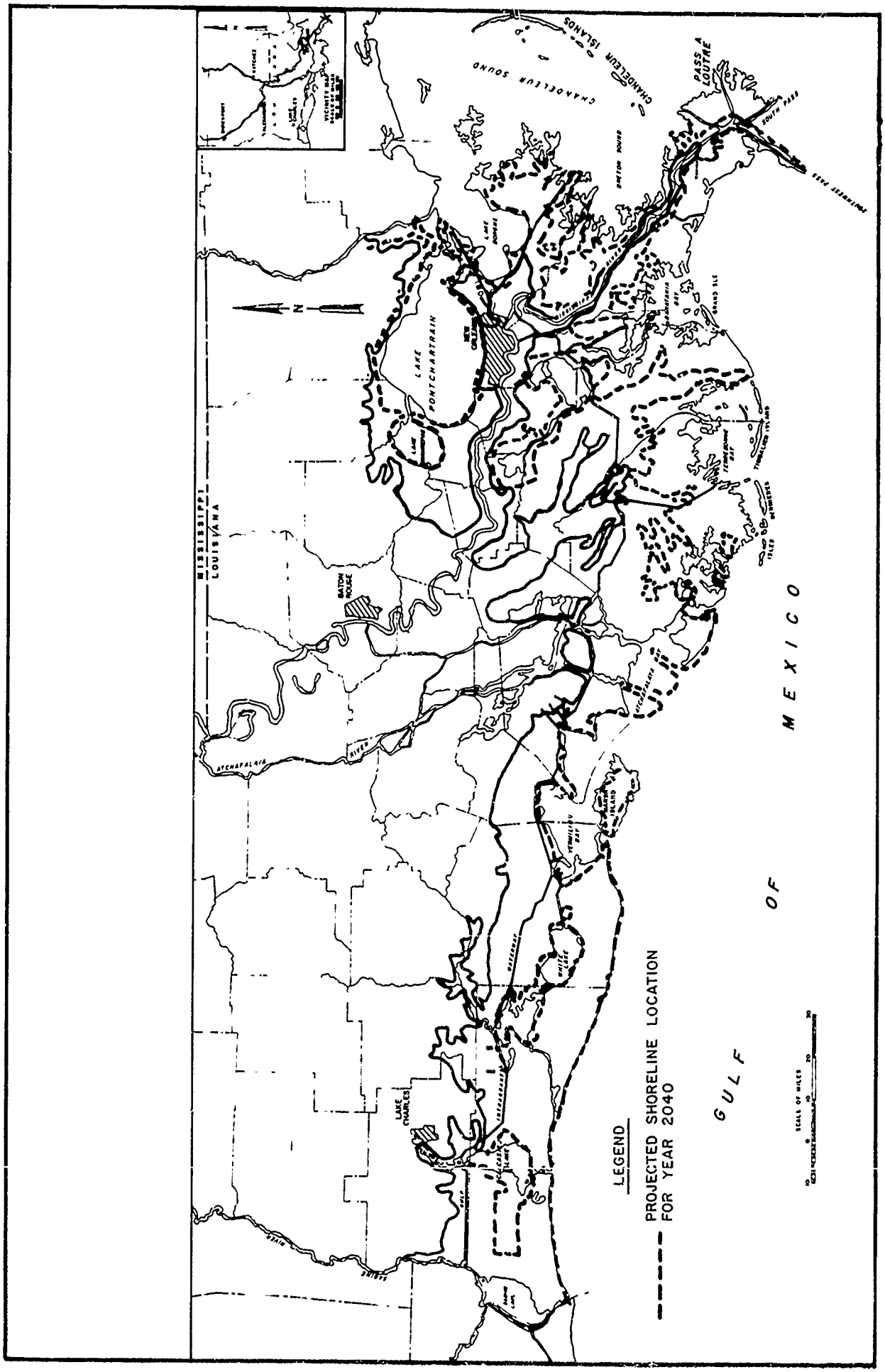


FIGURE 7. PROJECTED LAND AND WATER CHANGES AND SHORELINE IN 2040.

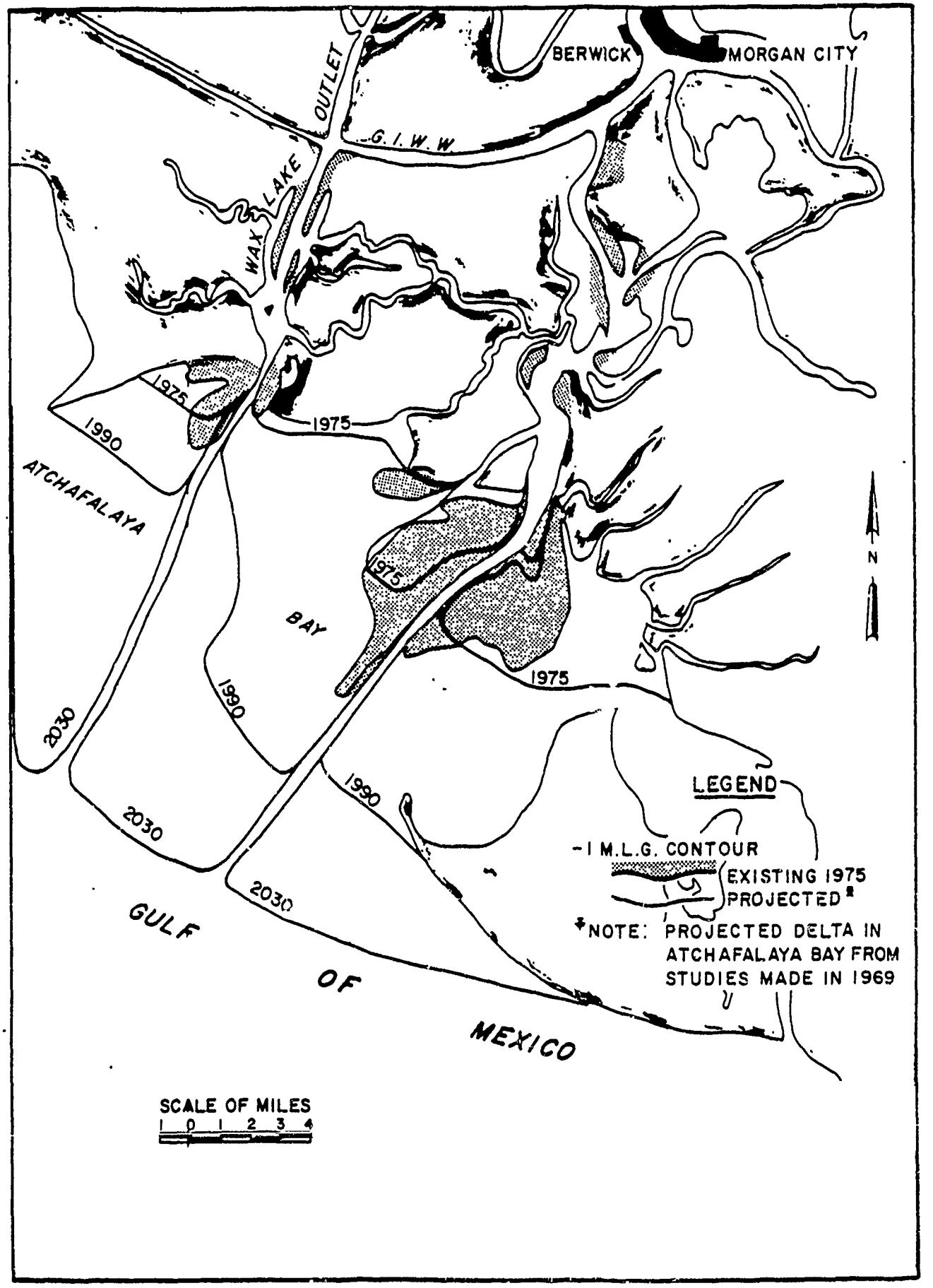


FIGURE 8. ANTICIPATED GROWTH OF ATCHAFALAYA DELTA.

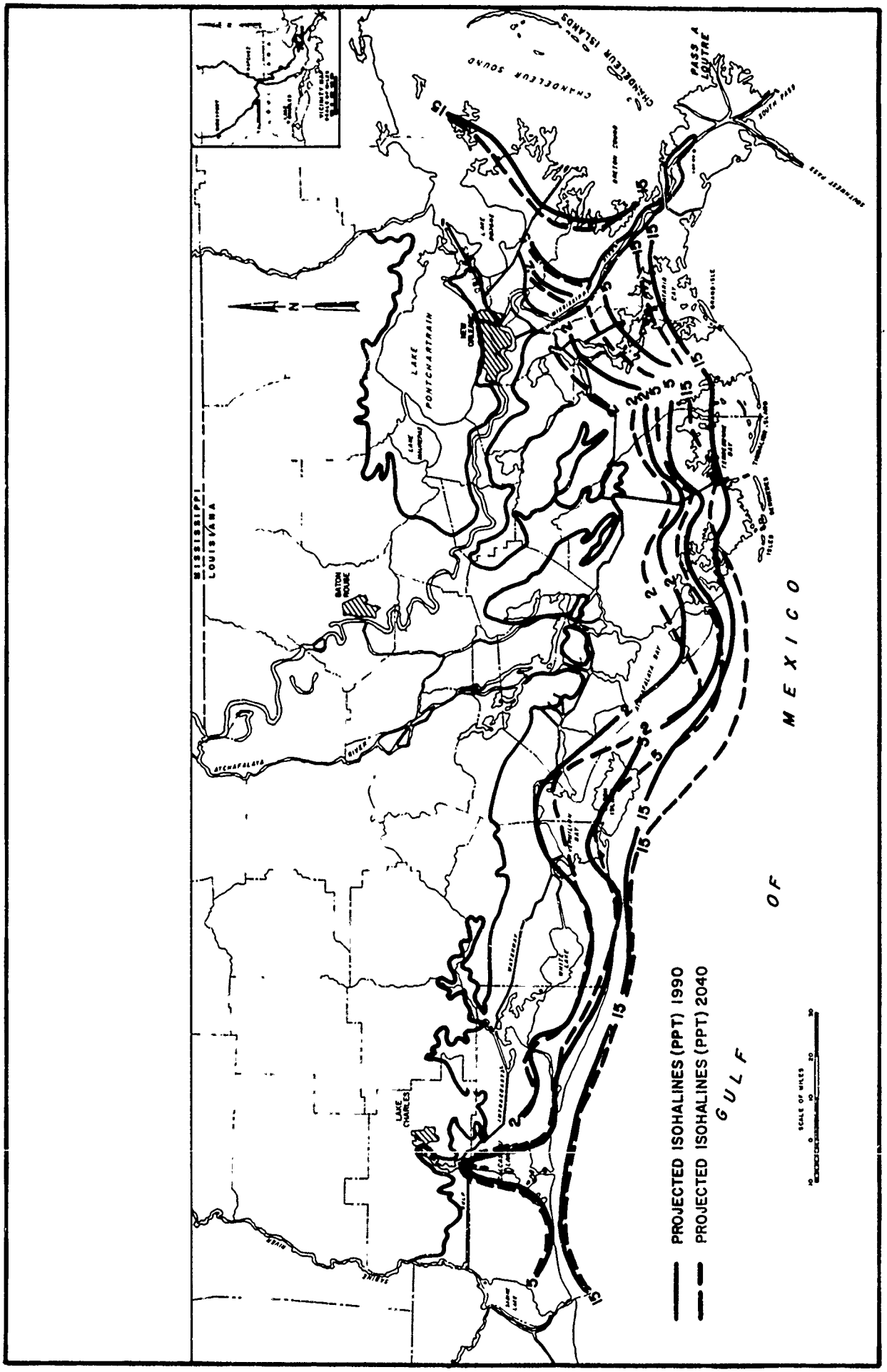


FIGURE 9. PROJECTED ISOHALINES.

source for municipal and agricultural purposes. Large shallow bays will form and the quality of their waters will be suitable for fish and wildlife propagation, and primary and secondary contact recreation.

BIOLOGICAL RESOURCES

The decrease in biological resources productivity will parallel the decline in quantity and quality of wetland habitat. Over the next 50 years, approximately 786,200 acres of wetlands including 148,100 acres of forested wetlands and 638,100 acres of marshland may be converted to open water (Table 5). These losses represent a reduction in forested wetlands and marsh acreage of 24 and 27 percent, respectively. The marshes not converted to open water would become more saline due to saltwater intrusion. The areal extent of low to moderate salinity marsh will be reduced. This will adversely affect wildlife production and decrease the commercial and recreational harvests. Other wildlife species important from an ecological standpoint will also be adversely affected. The marsh acreage is a critical limiting factor in fisheries production, according to many biologists. Habitat reduction and alteration will be accompanied by proportional declines in the production and harvest of estuarine-dependent fish species.

CULTURAL RESOURCES

The Louisiana Department of Culture, Recreation and Tourism, Division of Archaeology, has indicated that cultural resources throughout the coastal area are being affected by erosion, subsidence, energy-related activities, urban expansion, agriculture, and vandalism. These activities will continue to threaten and ultimately destroy approximately 50 percent of the region's known archeological sites.

RECREATIONAL RESOURCES

Recreation demands are expected to increase significantly in the future as a result of population growth. Sport fishing and hunting is projected to increase from 28.6 million man-days to 42.0 million man-days annually by the year 2040. The continued loss of productive marsh habitat will cause fish and wildlife oriented recreation opportunities to decline from 23.4 million man-days in 1990 to 17.0 million man-days in 2040.

HUMAN RESOURCES

Population in the study area is expected to increase from 2,247,000 in 1990 to 3,045,000 in 2040 (see Table 6). The pattern of regional urbanization is expected to continue with the population concentrating around the large urban parishes. The only foreseeable constraint on this trend would be if the developable lands are exhausted. The New Orleans MSA will maintain a significant share of the study area population in the future. The MSA is expected to account for 61 percent of the study area population in 2040.

Per capita income in the area is expected to increase 25 percent to $19,515 by 2040. The state and the national per capita incomes in 2040 are estimated at $19,112 and $19,024, respectively.

ECONOMY

Economic growth is expected to continue due to the activities related to the petroleum-chemical industries, domestic and foreign trade, fish and wildlife, recreation, and tourism. Employment in services, trade, and manufacturing are projected to increase, while employment in mineral production will decline. Activities associated with the fish and wildlife resources are expected to decline as a result of habitat losses. Continued habitat losses will cause the future fish and wildlife harvest to decline in value from $417 million in 1990 to $305 million in 2040 or approximately

TABLE 6

POPULATION PROJECTIONS FOR METROPOLITAN STATISTICAL AREAS (MSA)
AND PARISHES IN THE COASTAL AREA

Parishes and MSA's	1980	1990	2000	2010	2020	2030	2040
Baton Rouge MSA[1/,2/]	494,151	536,000	585,000	19,000	656,000	694,000	736,000
Ascension Parish	50,068						
Livingston Parish	58,806	118,000	129,000	137,000	145,000	154,000	163,000
Houma-Thibodeaux MSA[2/]	176,876	193,000	211,000	227,000	241,000	254,000	267,000
Lafourche Parish	82,483						
Terrebonne Parish	94,393						
Lake Charles MSA[2/]	167,223	183,000	199,000	211,000	223,000	237,000	250,000
Calcasieu Parish	167,223						
New Orleans MSA[2/]	1,256,668	1,353,000	1,464,000	1,551,000	1,644,000	1,740,000	1,844,000
Jefferson Parish	454,592						
Orleans Parish	557,927						
St. Bernard Parish	64,097						
St. Charles Parish	37,259						
St. John the Baptist Parish	31,524						
St. Tammany Parish	110,869						
Non-MSA Parishes	368,293	400,000	425,000	447,000	470,000	497,000	521,000
Assumption Parish	22,084	23,000	24,000	25,000	26,000	27,000	28,000
Cameron Parish	9,336	10,000	10,000	11,000	12,000	13,000	14,000
Iberia Parish	63,752	70,000	75,000	79,000	83,000	87,000	91,000
Jefferson Davis Parish	32,168	35,000	37,000	40,000	44,000	47,000	51,000
Plaquemines Parish	26,049	27,000	28,000	29,000	30,000	31,000	32,000
St. James Parish	21,495	22,000	24,000	24,000	24,000	26,000	26,000
St. Mary Parish	64,253	71,000	73,000	77,000	80,000	85,000	89,000
Tangipahoa Parish	80,698	89,000	97,000	102,000	108,000	115,000	121,000
Vermilion Parish	48,458	53,000	57,000	60,000	63,000	66,000	69,000
Total Coastal Area	2,077,934	2,247,000	2,428,000	2,573,000	2,723,000	2,882,000	3,045,000
Louisiana	4,206,312	4,539,000	4,901,000	5,582,000	5,582,000	5,780,000	6,202,000

SOURCE: US Dept. of Commerce, Bureau of the Census, 1980 Census of Populations, "Number of Inhabitants, Louisiana," and Bureau of Economic Analysis, 1980 OBERS Southwest BEA Regional Projections, Vol. 8.

1/ The Baton Rouge MSA also includes East and West Baton Rouge Parishes.
2/ MSA parish projections are included in the total.

27 percent. The commercial fisheries harvest will decrease by about $76 million and the wildlife harvest by about $4 million. Sport fishing and hunting values would be reduced by about $32 million. Table 7 presents the projected decline in harvest by major species.

Land use and development options will be restricted by projected land losses and shoreline changes. Approximately 786,200 acres of wetlands will be converted to open water. This will result in loss of the real estate value of the land and its productive value in terms of fish and wildlife resources. The total present value of these losses is estimated at $315 million (1983 prices), or about $26.4 million per year when expressed as an average annual value. Other losses include a reduction in fish and wildlife-related employment, and in esthetic, ecological, and cultural aspects of the marsh and its capacity to buffer hurricane flooding and treat domestic waste. The value of these losses has not been determined.

The land loss would also threaten existing public and private developments. Approximately 155 miles of navigation channels including such Federal navigation projects as the Mississippi River-Gulf Outlet, GIWW, Barataria Bay Waterway, and the Houma Navigation Channel will require increased maintenance dredging. A total of 55 miles of Federal hurricane protection projects including the Lake Pontchartrain and Vicinity, New Orleans to Venice, and LaRose to Golden Meadow projects will require erosion protection and enlargement to maintain their current level of protection. Figure 10 shows the Federal navigation and flood control projects that will be affected.

About 94 miles of Federal and state highways including portions of Interstates 10 and 55, U. S. Highways 11 and 90, and Louisiana Highways 1, 27, 56, and 82 will have to be protected or relocated. Erosion protection will be needed on 27 miles of railroad tracks. About 1,570 miles of oil and gas pipelines and 383 miles of gas, water, electric power, and telephone lines will have to be relocated. Approximately 1,800 structures

TABLE 7

PROJECTED DECLINE IN FISH AND WILDLIFE HARVEST
DUE TO HABITAT LOSSES

Activity	1978	1990	2000	2020	2040
			(millions)		
Commercial					
Menhaden					
pounds	955.30	883.76	827.49	722.50	646.08
value ($)	38.85	35.94	33.65	29.38	26.27
Shrimp					
pounds	152.72	141.28	132.29	115.50	103.28
value ($)	210.95	195.15	182.73	159.54	142.66
Oyster					
pounds	27.07	25.04	23.45	20.47	18.31
value ($)	41.53	38.42	35.98	31.40	28.09
Blue Crab					
pounds	13.06	12.08	11.31	9.88	8.83
value ($)	3.55	3.28	3.07	2.68	2.40
Other Fish 1/					
pounds	33.62	31.43	29.65	26.19	23.59
value ($)	12.77	11.94	11.26	9.95	8.95
Alligator					
hides and meat	0.015	0.014	0.013	0.012	0.011
value ($)	2.73	2.52	2.34	2.16	1.98
Furbearers 2/					
pelts and meat	2.15	1.98	1.86	1.62	1.45
value ($)	13.76	12.73	11.96	10.42	9.32
Recreational					
Fish 3/ Wildlife 4/					
man-days	25.29	23.39	21.90	19.13	17.01
value ($)	126.45	117.00	109.50	95.65	85.05
Total Value ($)	450.59	416.98	390.49	341.18	304.72

1/ Atlantic croaker, seatrout, spot, and red drum.
2/ Muskrat, nutria, mink, raccoon, otter, bobcat, and fox.
3/ Freshwater and saltwater species.
4/ Deer, rabbit, squirrels, waterfowl, and other marsh birds.

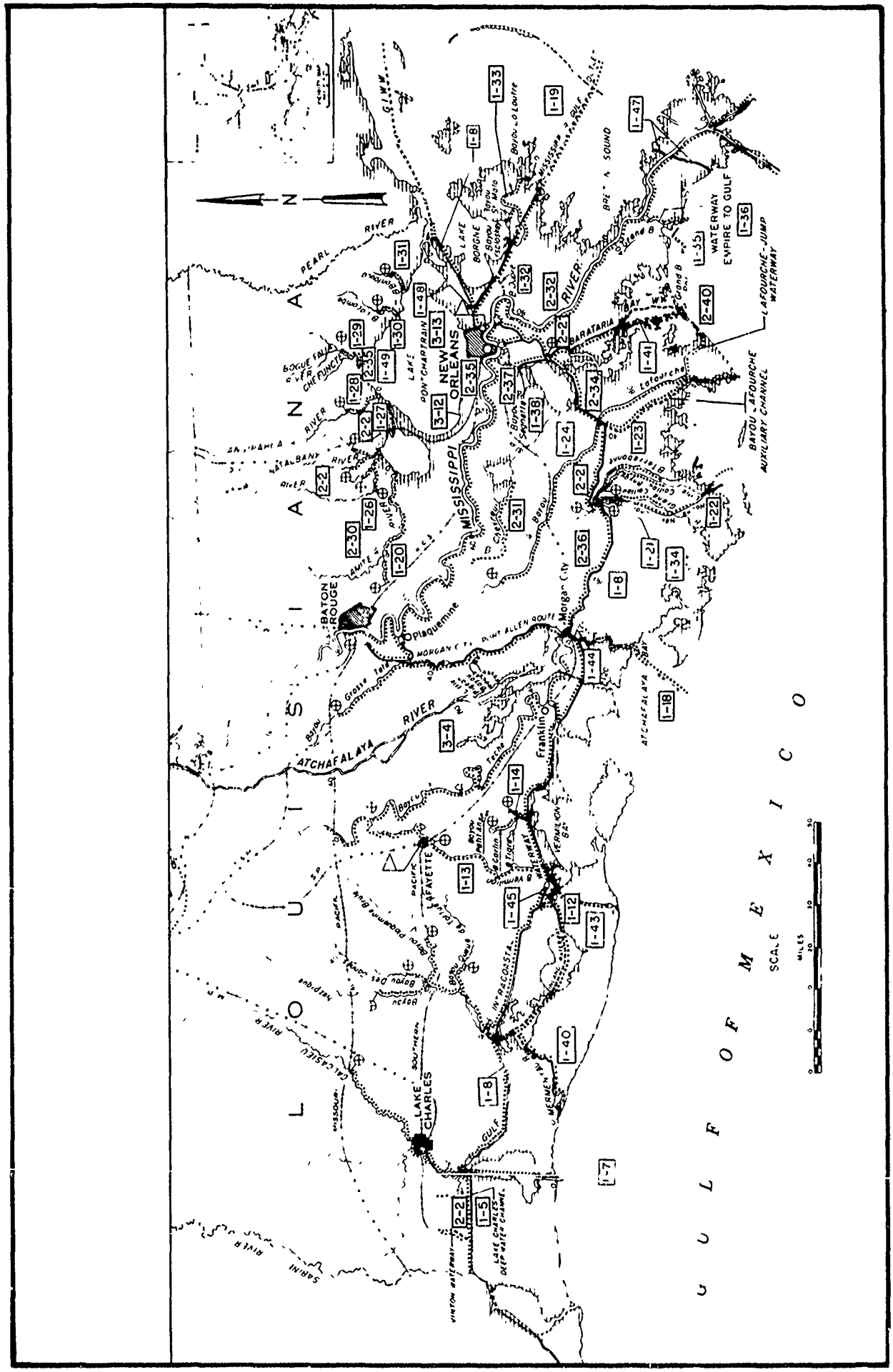


FIGURE 10. AFFECTED FEDERAL NAVIGATION AND FLOOD CONTROL PROJECTS.

including businesses, residences, camps, schools, pumping plants for gas, oil, and water, storage tanks, water control structures, and electric power substations will have to be protected or relocated. The present value of the losses to the public and private sectors could total $285 million, or about $23.6 million per year. Table 8 presents the possible damages to existing development by Parish and the present value of these losses. Figure 11 depicts the highways and buildings that will be affected.

In addition to these losses, developed areas in and immediately adjacent to the coastal area will be more susceptible to flooding. The increased flood hazards will restrict development in low areas and require extensive flood protection measures. Development will be concentrated in leveed or elevated areas along the Mississippi River and its abandoned distributaries and the cheniers to the west. As the protected and elevated lands are exhausted, the uplands immediately adjacent to the study area will become more attractive for development.

PROBLEMS, NEEDS, AND OPPORTUNITIES

To develop the coastal area's resources and provide for the needs of the people who live in the area, national, state, and local interests have made a tremendous investment in public and private developments in the Mississippi delta region and throughout the coastal area. This investment has made enormous economic growth possible. But the growth has not been without consequence. Development in this fragile environment threatens the wetland's very vitality and capacity to support diverse activities important to the nation and state.

PROBLEMS

The long-term natural causes of land loss are compaction of sediments, subsidence, sea level rise, and erosion (Adams et al., 1976, Craig et al., 1979, and Bahr et al., 1983). These factors have produced a net change in the land and water surface elevations. Long-term subsidence rates appear

TABLE 8

POSSIBLE DAMAGES DUE TO PROJECTED LAND LOSSES
AND SHORELINE CHANGES BETWEEN 1990 AND 2040

Parish	Roads	Railroads	Waterways	Gas & Oil Pipelines	Utilities[1]/	Levees	Facilities[2]/	Buildings[3]/	Agricultural Lands	Present Value[4]/
	Miles						Number	Number	Acres	($1,000)
Cameron	31.8	0	22.5	29.1	108.6	0	2G, 1M, 1C	350	8,000	28,400
Iberia	0	0	10.0	10.2	0	0	0	1	0	2,200
Jefferson	0	0	23.0	163.4	0	10.0	3G, 1F	260	0	14,600
Lafourche	25.5	1.2	13.5	281.7	102.0	13.0	4G, 12T, 1P	182	0	55,100
Orleans	8.0	5.0	0	0.6	36.0	12.0	2F	12	0	13,100
Plaquemines	0	0	27.0	723.2	0	20.0	5G	2	0	37,500
St. Bernard	0	0	15.0	2.2	0	0	0	1	0	78,800
St. Charles	4.0	2.5	0	0	16.0	0	1W, 1M	239	1,000	5,100
St. John the Baptist	3.5	10.0	0	6.4	0	0	0	22	0	9,300
St. Mary	4.0	0	11.0	7.7	8.0	0	0	2	0	800
St. Tammany	10.0	7.0	2.5	12.3	32.0	0	0	159	0	12,200
Tangipahoa	2.5	1.0	0.7	0	0	0	0	9	0	1,700
Terrebonne	4.5	0	26.5	306.2	80.0	0	3G, 2W, 1E	527	0	25,300
Vermilion	0	0	4.0	26.5	0	0	0	0	0	900
Total	93.8	26.7	154.7	1,569.5	328.6	55.0	40	1,766	9,000	285,000

1/ Includes gas and water pipelines, electric power and telephone lines.
2/ Pumping plant-gas and oil (G) or water (W), storage tank (T), microwave tower (M), water control structure (C), power substation (E), and port (P).
3/ Includes businesses, residences, camps, schools, churches, and cemeteries.
4/ The losses would occur during the period 1990 to 2040, but have been brought to present value and are expressed in 1983 dollars, using a discount interest rate of 8-1/8 percent.

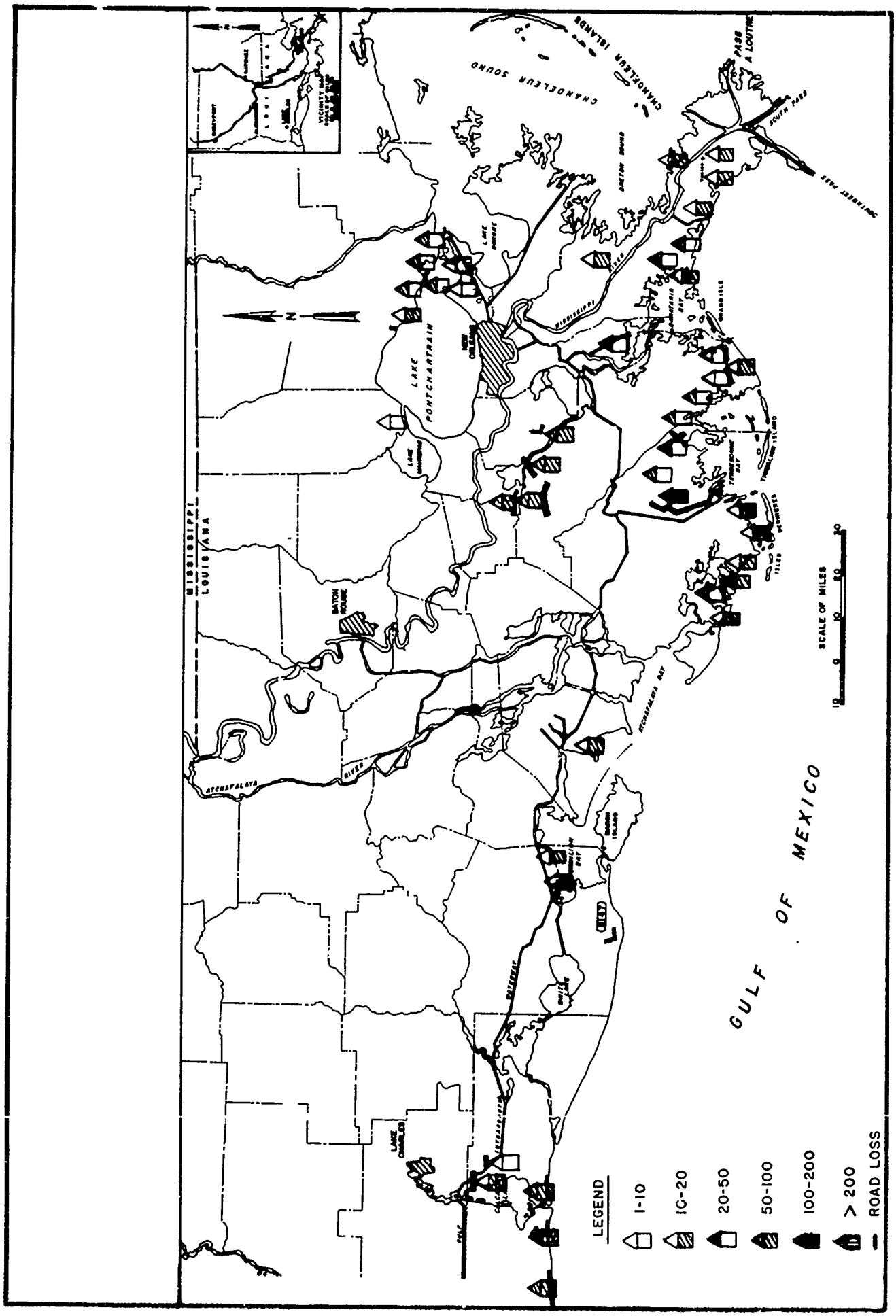


FIGURE 11. AFFECTED ROADS AND BUILDINGS.

to have slowed over time: 1.8 feet per century over the last 7,000 years, 1.1 feet per century over the past 3,500 years, and 0.9 feet per century over the last 1,000 years (Penland and Boyd, 1983, and Gerdes, 1982). Some short-term measurements indicate that the subsidence rates appear to have varied between 0.9 and 2.7 feet per century during the period 1848 to 1959 (Bahr et al., 1983).

Sea level rise is occuring throughout the gulf coastal area. An accurate assessment of relative sea level rise is difficult due to the short duration and discontinuous records at most tide gauges. However, examination of 700 gauge records from around the world indicates that the global mean sea level rose approximately 0.4 feet over the past 100 years (Gornitz et al., 1982 and Nummedal, 1983). From the available data, it can be concluded that over the long term, sea level rise has been a relatively minor contributor to land loss when compared to subsidence.

In modern times, flood control levees along the Mississippi and Atchafalaya Rivers have altered deltaic land building processes by virtually eliminating all overbank flooding. The only new lands being built are the delta in Atchafalaya Bay and the mudflats along the Vermilion Parish coast. The Mississippi River is depositing its annual sediment load of 189 million tons in deep water near the edge of the continental shelf, eliminating this sediment as a source for land building. However, the sediment is contributing to the loading and depressing of the area. For a time, marsh vegetative growth and organic matter accumulation on the marsh floor kept pace with the processes of decay. But without the revitalizing flood of waters and sediment, the land subsided and the marshes that were not salt tolerant were destroyed and replaced by open water. The marsh/water interface, erosion, and saltwater intrusion increased. Eventually, the destructive processes became dominant in most of the area, resulting in land loss and rapid retreat of the shoreline.

Dredging of an estimated 8,200 miles of canals for navigation, drainage, and oil and gas activities has intensified the destructive processes. The canal dredging has caused nearly 40 percent of the manmade marsh loss

(Gagliano et al., 1973). The canals segment the marsh, disrupt water and nutrient dispersion, expose the weak marsh soils to increased erosion by wind driven waves and boat wash, and provide avenues for saltwater to intrude into the fresh marshes.

The loss of water and sediment has intensified the effects of compaction, subsidence, sea level rise, erosion, and saltwater intrusion and man's activities. Collectively, these factors have caused land loss. In the past 80 years, approximately 800,000 acres of deltaic plain wetlands have been lost to open water. More than 58 percent of this loss occurred in the last 25 years (Gagliano, 1981). An additional 655,200 acres have been developed for agricultural, urban, and industrial uses.

Recent studies predict significant changes in the relative land and water surface elevations. A subsidence rate as high as 3.0 feet per century has been predicted for the coastal area (Nummedal, 1983). This rate is nearly double the average rate of subsidence for the past 7,000 years. Based on long-term trends, it is reasonable to expect the coastal area to subside about 0.9 feet by the year 2040. The subsidence is caused by loading, compressing, and depressing the sedimentary deposits, and tectonic activities. Other studies indicate that changes in the earth's climate could possibly induce a substantial rise in global sea level (Hoffman et al., 1983). The studies noted that rising concentrations of critical atmospheric gases, such as carbon dioxide, may trap heat and radiate it back to the earth's surface, raising the temperature. The temperature rise could possibly trigger a global warming or "greenhouse effect." The warming could change the ice and snow on the land to water that would then enter the oceans. The oceans could absorb the heat directly and that could cause thermal expansion of the water. Together, these factors could possibly produce a sea level rise that would exceed the past historical trend. Knowledge of the atmospheric and climatic changes and the glacial and oceanic response to those changes is limited. But scientists believe it is possible to predict the most likely range of sea level rise by modeling such factors as population and productivity growth, consumption

of fossil fuels, atmospheric and climatic change, and glacial and oceanic responses. By linking these factors together, the most likely range of sea level rise was estimated at 1.4 to 2.1 feet by the year 2040 (Hoffman et al., 1983). This is nearly 7 to 10 times the historic rate of sea level rise. Based on historical trends, it would be reasonable to expect a sea level rise of 0.2 feet by 2040. This rise would increase the area inundated by the gulf, erosion, saltwater intrusion, and the height of hurricane-induced flooding.

Land subsidence and sea level rise could produce a net change in land and water surface elevations of 1.1 feet by the year 2040. These changes, along with increased erosion and saltwater intrusion, have serious implications for the coastal area. Approximately 786,200 acres of wetlands would be lost to open water. The interior marshes would be subjected to increased erosion and saltwater would intrude further inland into aquatic and terrestrial habitats. As a result, the saline zone would expand and significantly reduce the fresh-intermediate and brackish zones. The extensive low to moderate salinity marshes and water bodies are vital nursery grounds for the juvenile stage of most estuarine-dependent commercial and sport finfish and shellfish species. As saltwater intrusion narrows the broad, low to moderate salinity zone, the size of the nursery area will be reduced. The increased salinities will cause marked changes in vegetative types. The less tolerant plants will die and be supplanted by more salt-tolerant plants. The habitat types preferred by the important commercial and sport wildlife species will then be reduced. Biologists are in general agreement that the loss of habitat and deterioration of the quality of the remaining habitat will adversely affect fish and wildlife productivity. The loss in productivity will cause a 32-percent decline in the commercial and sport fisheries and wildlife harvests. The gradual loss of the fish and wildlife harvests and the real estate value of the wetlands could reach $315 million by 2040. The decline in fish and wildlife harvests would result in the loss of jobs in the commercial and recreational fish and wildlife-related industries, and would lower economic activity. The sport fishing and hunting experience would suffer qualitatively.

The land loss and the advancing gulf waters would damage coastal communities, water supplies, and much of the public and private developments. Hurricane protection levees, navigation channels, highways, railroad tracks, oil and gas pipelines, utility and telephone lines, and businesses, camps, residences, schools, and churches, would have to be protected or relocated. The present value of these losses is estimated at $285 million. In addition, lands within and immediately adjacent to the study area would have an increased susceptibility to hurricane-induced flooding that would limit future development options. Some areas will require enlargement and erosion protection of existing hurricane protection levees to maintain the current level of protection.

Land loss in this vital area will alter the biological productivity of the wetlands, endanger the esthetic, ecologic, and cultural resources of the region, and diminish the marsh's capacity to dampen the hurricane-induced flooding that threaten man's use and enjoyment of the area. The interrelationship of the factors involved in land loss is significant, each causing or intensifying the other. Therefore, addressing one factor will influence all others.

NEEDS AND OPPORTUNITIES

Needs in the study area include:

o Reduce land loss due to subsidence, sea level rise, erosion, saltwater intrusion, and man's activities.

o Reduce loss of marsh's capacity to buffer hurricane-induced flooding and treat domestic waste.

o Reduce loss of the marsh's highly prized esthetic, ecological, and cultural resources and unique cultural heritage.

o Reduce habitat deterioration and increase nutrients and sediments in the estuarine-marsh areas to enhance marsh vegetation and improve fish and wildlife production.

o Increase recreational opportunities.

The abundance and diversity of aquatic and terrestrial habitat types affects the biological productivity of the fish and wildlife resources in the estuarine-marsh complex. Measurement of the relationship between habitat and productivity of all resources is difficult and can best be discussed primarily in qualitative terms; that is, an adverse or beneficial change in environmental conditions is followed by a corresponding change in productivity. However, the relationship of marsh vegetation to the productivity of the commercial fish and wildlife resources has been documented. Biologists generally agree that habitat reduction would be accompanied by diminished harvests (Craig et al., 1979). Shrimp and menhaden yields have been correlated directly to the area of intertidal wetlands (Cavit, 1979 and Turner, 1979). The Environmental Protection Agency (1971) has indicated that none of the major commercial fish species would continue to exist in commercial quantities if estuaries were not available for development. Reduction in habitat and nursery areas will lead to a reduction in fish and wildlife harvest. Most biologists believe that total estuarine-dependent commercial fisheries production has peaked and will decline in proportion to the acreage of marsh loss (Harris, 1973).

Increasing nutrients and sediments in the estuarine area would enhance the growth of marsh vegetation and slow the rate of land loss. Increased plant growth would result in greater production of organic detritus that is essential for a high rate of fisheries production. Production of phytoplankton and zooplankton would increase in areas where turbidity is not limiting and, as a result, the harvest of sport and commercial finfish and shellfish that depend on these microorganisms would increase.

Sport fishing and hunting is related to availability of fish and wildlife resources and access to these resources. By the year 2040, the fishing and hunting demand is expected to reach 42 million man-days. But, the projected loss in habitat will decrease sport fishing and hunting opportunities to 17 million man-days valued at $85 million. The loss of habitat does not reduce the resource base for fishing, but habitat deterioration would reduce potential fish harvest. As a result, the "expected catch" would be reduced and the quality of the fishing experience would be lowered. Enhancing habitat conditions would increase sport fishing and hunting opportunities.

The diversity and productivity of the coastal area is a direct result of hydrologic processes. Extensive marshes resulted from long-term sediment deposition by the Mississippi River system and long shore currents. Plant and animal communities have developed in response to complex, subtle variations in water chemistry, flood cycles, and erosional processes. Water flow carries nutrients and sediments into the system, eliminates waste products and constantly redistributes the energy flow between primary and secondary productivity.

Land building resulted formerly from natural crevasses along the Mississippi River levee system. The birth, life, and death of a subdelta lobe can take place in the brief period of a century. Under proper conditions, land accretion can occur at a surprisingly rapid rate.

The sole significant source of new land in recent times has been the delta building in Atchafalaya Bay and the mudflats developing along the Vermilion Parish coast. The delta is expected to grow at an average rate of 3,400 acres per year. This will result in a net land loss rate of about 21,900 acres per year. Under optimum conditions, the goal of sediment diversions would be to create marsh at a rate equal to the rate of loss. Studies of the historical development of four modern subdeltas indicate that if the entire 189 million tons of sediment carried by the river in an average year

were diverted into relatively shallow waters adjacent to the east and west banks of the river about, 5,000 acres of marsh per year could be developed through deltaic action. This is about 23 percent of the current annual net land loss.

Controlled diversions into marshes with water depths averaging about 5 feet would require relatively less sediment for each acre of new land and probably be more effective in counteracting land loss than the building of subdeltas in relatively deep water. Crevasses into waters with depths of approximately 12 feet may be a practical and effective means of creating land in bays and sounds adjacent to the Mississippi River, but will require substantially more sedimment for each acre of marsh created.

In creating new land, it is not desirable to completely fill the receiving water bodies. Rather, it would be more desirable to transform large lakes and bays into a series of interconnecting ponds with shallow water depths. Judicious spacing of the subdelta lobes would substantially increase the land/water interface which is more attractive to marsh and estuarine life forms. The introduction of sediment should be carried out periodically. This would allow plants and animals to invade and establish themselves in the newly made areas shortly after they are formed.

Land loss can also be reduced by placing dredged material in open water areas. The New Orleans District excavates 60 million cubic yards of material annually in maintenance dredging of navigation channels. The district has placed dredged material to create about 3,000 acres of land. Placing the entire 60 million cubic yards of material in water bodies up to nine feet in depth and allowing for losses due to compaction, subsidence, and erosion, could result in the creation of 4,300 acres of marsh per year. This is approximately 20 percent of the current annual net land loss. Dredging material from sediment-rich areas could create about 360 acres per year per dredge. Employing four dredges in the Mississippi River and one in Chandeleur Sound could create about 1,800 acres of marsh per year. By combining the methods of sediment diversion and the methods of

placing dredged material, it may be possible to generate up to 11,100 acres of marsh per year. Thus, we can only create approximately 51 percent of the current annual net loss of 21,900 acres.

Opportunities are available in the estuarine-marsh complex to reduce land loss, increase the nutrient and sediment supply to enhance vegetative growth, reduce subsidence, preserve the marsh's capacity to buffer hurricane flooding, improve commercial fish and wildlife production,and increase recreation potential. These opportunities can be realized by sediment diversion, placing dredged material in open water areas, injecting liquids into subsurface strata, and regulating alteration of marsh areas.

RECOGNITION OF SIGNIFICANT RESOURCES

Institutional, technical, and public interests have recognized the significance and value of marshes as an essential part of the highly productive estuarine ecosystems in coastal Louisiana. Institutional recognition has been made apparent by passage of the Federal Coastal Zone Management Act of 1972, Louisiana State and Local Coastal Resources Management Act of 1978, Estuary Protection Act, Executive Order 11990 (Protection of Wetlands), and Executive Order 11988 (Flood Plain Management). All of this legislation has been passed to ensure that our nation's coastal wetlands are protected and to maintain their ecological integrity.

From a technical perspective, the importance of marshes is recognized by ecologists and fish and wildlife biologists. Marshes provide habitat and nursery grounds for numerous species of estuarine-dependent finfish and shellfish and their contribution to Louisiana's commercial and recreational fishery harvests is widely acknowledged by fishery experts. Marshes are also used extensively by many important wildlife species including big and small game mammals, furbearers, alligators, resident and migratory waterfowl, and a variety of wading birds, shorebirds, birds of prey, and

passerine birds. The marshes of Louisiana also provide habitat for a number of endangered and threatened species as well as 18 species considered by the U.S. Fish and Wildlife Service to be National Species of Special Emphasis.

There is also widespread public recognition of the significance of marshes. Many environmental groups are very concerned over the degradation of the marshes and direct their efforts to preserving marsh habitat. The problems facing Louisiana's coastal marshes have been widely publicized and have received extensive coverage via the news media.

PLAN FORMULATION

PLANNING OBJECTIVES

As a result of the analysis of changing conditions, the needs and opportunities and concerns of Federal, state, and local interests, the following planning objectives were established:

o Create marsh to offset losses.

o Enhance marsh vegetative growth to reduce marsh losses and increase the nutrient and detritus supply for fish and wildlife production.

o Reduce subsidence, erosion, and saltwater intrusion to reduce marsh losses.

o Preserve some of the marsh's capacity as a buffer against hurricane tides to protect development and use of the area.

o Preserve some of the marsh's unique and highly prized esthetic, ecological, and cultural attributes to ensure man's enjoyment and to preserve lifestyles and cultural heritage.

o Improve commercial fish and wildlife production to meet a portion of the demands for fish and wildlife products, increase job opportunities in fish- and wildlife-related industries, and stabilize wide fluctuations in the fish and wildlife industries.

o Improve sport fishing and hunting opportunities to satisfy a portion of the sport fishing and hunting needs and to improve the quality of the fishing and hunting experience by minimizing the reduction in the "expected harvest".

PLANNING CONSTRAINTS

Legislative and executive authorities specify planning constraints and criteria that must be applied when evaluating alternative plans, including the range of impacts to be assessed. In developing plans, both tangible and intangible benefits and costs were considered as well as effects on the ecological, social, and economic well-being of the region. Federal participation in development requires that any plan be complete in itself, efficient and safe, economically feasible in terms of current prices, environmentally acceptable, and consistent with local, regional, and state plans.

In the estuarine-marsh complex, there is a synergistic relationship between compaction, subsidence, sea level rise, erosion, saltwater intrusion, fresh water, sediment, nutrients, and resource productivity. The factors causing land loss have already affected the area, the fish and wildlife resources, and man's developments and enjoyment of the area. Creating desirable habitat conditions and associating these changes to increases in primary productivity of habitat types and fish and wildlife populations is a complex problem. Actual experience with creating marsh for the purpose of conserving and enhancing fish and wildlife resources is limited in scope and duration. The fact that there is a relationship between changes in physical and chemical parameters and biological communities clearly emerged as the effects of diversion for flood control and placing dredged material

were observed. The Corps has created about 3,000 acres of land using material from maintenance dredging of navigation channels. Current understanding of the specific effects on biological resources is based partly on several small-scale diversions and dredged material disposal programs to enhance fish and wildlife, but is largely the result of inductive reasoning and expert judgement.

There is no single accepted method for relating primary productivity to the harvest of fish and wildlife and the benefits derived from freshwater, sediment, and nutrient inputs. Studies to refine presently known information would require many years of basic research, extensive data collection, and development of hydrologic and water quality models. In view of this constraint, the most reasonable approach was to limit the study effort to review and evaluation of existing information and available data. These sources were used to the maximum practical extent. To overcome deficiencies in other available information would require some state-of-the-art research. New methodologies were developed to predict future conditions with and without a project and to evaluate commercial and recreational fish and wildlife benefits attributable to marsh creation. Much of this effort depended on the expert judgement of personnel from the Corps and other Federal, state and local agencies.

The widely varying salinity requirements of many fish and wildlife species is another constraint. For example, brown shrimp prefer relatively higher salinities than white shrimp. Salinity requirements vary with the life stage of most estuarine-dependent species. Wildlife also have differing salinity requirements. The majority of important wildlife species require fresher habitats, but some species prefer more saline areas. Therefore, it was necessary to determine a salinity regime best overall for fish and wildlife production. Achieving salinity gradients to improve wildlife could reduce the width of the salinity zone that fish require. Attaining the desired salinity gradient for fish would increase the wildlife-preferred habitat. Moving salinity gradients further gulfward would maximize benefits to wildlife but would severely reduce fish nursery areas. Thus, a major constraint is to avoid overfreshening the estuaries.

Restoring the former overflow regime of the Mississippi River and its distributaries is impractical due to development along the river., communities depending on the river as a raw water source and for navigation, and the extensive oyster farms in the bays adjacent to the river. However, the river's overflow regime can be imitated by diverting sediment-laden water into the marshes and estuaries. Thus, major contraints were to avoid depositing sediment on valuable oyster growing beds and to avoid adverse effects on water supply and navigation. The adverse effects on estuarine organisms will be minimized by timing the releases with the river's normal overflow regimen and the ingress of juvenile organisms. The impacts on water supply and navigation will be avoided by diverting water only when the river flow exceeds 300,000 cfs.

The water quality of the Mississippi River, the source of supplemental water, is a major concern. Numerous chemical compounds are discharged daily into the river. Knowledge of short-and long-term effects of the contaminants on fish and wildlife is very limited. Assessing these impacts with any degree of certainty would require some basic research, extensive data collection, and development of hydrologic and water quality models. This effort would take many years. In view of the data gaps and uncertainties, this study relied on the review of available information and professional opinion in evaluating potential impacts.

Water temperature is also a constraint. The Mississippi River is generally cooler than the receiving waters from January through July. Water temperatures can affect migration and growth rates in sensitive juvenile aquatic organisms. Since large numbers of juvenile organisms arrive in the estuaries during the spring, a major constraint was to avoid thermal shock to immigrating juveniles by limiting the quantity of diverted water after April, or by introducing the water into semi-enclosed areas which would allow time for the water to warm.

MANAGEMENT MEASURES

Measures identified that could address one or more of the planning objectives are:

- o Divert sediment-laden water.
- o Place dredged material in open water bodies.
- o Inject liquids into subsurface strata.
- o Regulate alteration of wetlands.

Table 9 shows the planning objectives that each measure would meet.

The measures include suggestions made by participants at public meetings and by representatives of interested Federal, state, and local agencies at coordination meetings. Each measure could be accomplished in numerous ways [illegible] binations between measures could produce innumerable alternative [illegible]. Therefore, each measure was subjected to analysis and screening prior to developing specific plans. The analysis and screening depended on available information, generalized analyses developed from available information, and the judgement of individuals where information was incomplete or too time-consuming to develop. Preliminary designs were developed and estimates of benefits and costs were made to provide a basis for screening the measures. The measures retained were used to formulate specific plans.

SEDIMENT DIVERSION

Sediment-laden river water could be diverted through a channel cut from the river to the receiving water body to create marsh. This would contribute to preserving wetlands, enhancing vegetative growth, offseting some of the

TABLE 9

MANAGEMENT MEASURES AND PLANNING OBJECTIVES THEY MEET

Measures	Planning Objectives						
	Create Marsh	Enhance Vegetative Growth	Reduce Subsidence, Erosion, & Saltwater Intrusion	Preserve Buffer Against Hurricane Flooding	Preserve Esthetic, Ecological, & Cultural Attributes	Improve Commercial Fish & Wildlife Production	Improve Recreational Fish & Wildlife Production
Sediment Diversion	+	+	+	+	+	+	+
Place Dredged Material	+	+	+	+	+	+	+
Inject Liquids in Subsurface Strata	0	0	+	0	0	0	0
Regulate Alteration of Wetlands	0	0	+	+	+	0	0

losses due to compaction, subsidence, erosion, and saltwater intrusion, preserving some of the marsh's capacity to buffer hurricane flooding, preserving some of the esthetic and ecologic attributes and cultural heritage, improving commercial fish and wildlife production, and improving sport fish and wildlife opportunities. There are two ways to divert the water--breach the levee with an artificial crevasse or build a structure into the levee to regulate the flow. Breaching a mainline levee could raise the possibility of a river diversion during a flood. Thus, the artificial crevasses or uncontrolled diversions were limited to the distributaries of the river below Head of Passes. Figure 12 depicts a typical uncontrolled diversion. In the initial investigation, only five potential crevasse sites were selected (Figure 13). A preliminary design was developed that includes a cut 20 feet deep over a bottom width of 80 feet and side slopes of one vertical and three horizontal. The length of the cut varied from 50 to 200 feet. This measure imitates the natural process of river crevasse and overflow in which sediments are deposited in deltaic splays in low lying areas. The deltaic splay will develop to the height of highwater. As the delta matures, the natural delta building process decreases in efficiency (i.e., with the same auantity of water and sediment, the rate and amount of marsh created decreases over time). About 420 acres of marsh would be created at the five sites in the first two years, but over 50 years only 5,200 would be created. The cuts will have to be reopened and extended, or relocated every two or three years. The cost of creating marsh was estimated at an average of $1,200 per acre per year (Table 10). All five sites were retained for plan formulation. In future studies, other suitable uncontrolled diversion sites will be examined.

The controlled diversions could be by gravity flow control structures, siphons, or pumping stations. Siphons were determined to be impractical due to the quantity of flow needed (25,000 cfs or greater) and accompanying head loss. Pumping stations are more costly to construct, operate, and maintain than gravity flow structures. Thus, gravity flow control

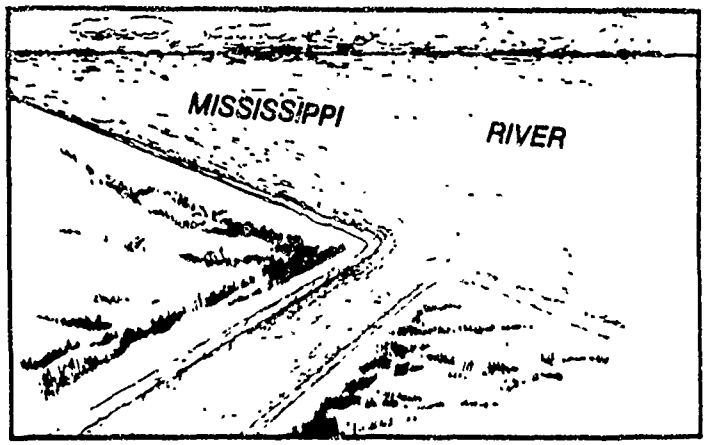


FIGURE 12. TYPICAL UNCONTROLLED SEDIMENT DIVERSION.

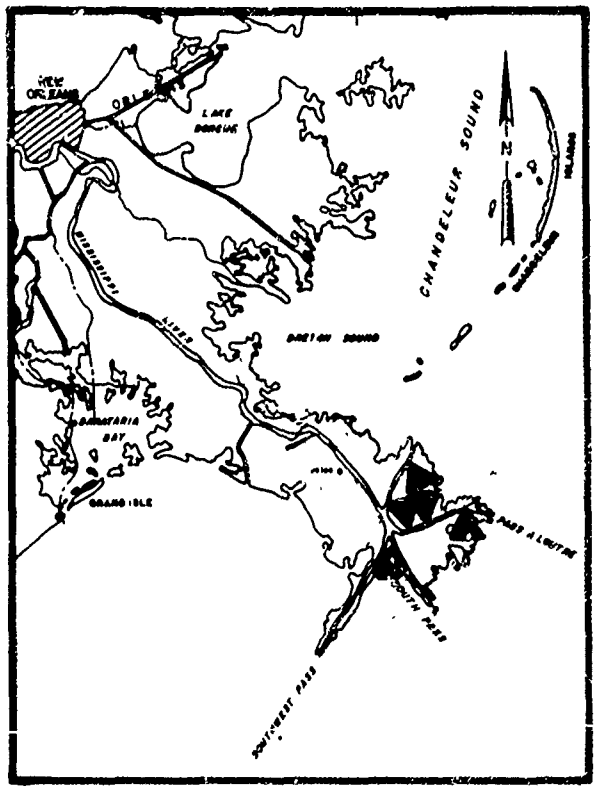


FIGURE 13. LOCATION OF UNCONTROLLED SEDIMENT DIVERSION SITES.

TABLE 10

MARSH CREATION WITH UNCONTROLLED SEDIMENT DIVERSIONS

Site Location	Dredging Requirements (Cubic Yards/ Year)	Marsh Created[1] (Acres/Year)	Cost of Marsh[2] (Dollars/Acres)
Octave Pass, South Bank	27,000	7.5	$ 7,668
Raphael Pass, North Bank	13,500	7.5	3,834
Pass a Loutre, North Bank	28,000	50.0	1,193
Pass a Loutre, South Bank	15,500	100.0	330
South Pass, West Bank	33,500	45.0	1,586

1/ Based on first two years of operation. The rate will decrease over time.

2/ Based on the initial cut in first two years. Successful operation for more than two years would decrease the cost per acre.

structures were chosen for further consideration. Figure 14 depicts a typical control structure. Seven controlled diversion sites between miles 6 and 35 above Head of Passes were identified in earlier studies (USACE 1970 and 1974). Each site was analyzed for flows of 25,000 and 100,000 cfs. The sites shown on Figure 15 represent locations where connections to the river previously existed or where development is sparse. The two sites recommended in the Louisiana Coastal Area - Interim Feasibility Report on Freshwater Diversion to Barataria and Breton Sound Basins were considered in place. They are the Caernarvon site in the Breton Sound Basin and the Davis Pond site in the Barataria Basin. The freshwater diversions would retard saltwater intrusion and reduce marsh loss by 99,200 acres over 50 years. The recommended diversion site at the Bonnet Carre' Spillway in the Mississippi and Louisiana Estuarine Areas Study will save 10,500 acres of marsh and swamp over 50 years.

In creating marsh with controlled diversions, the major concerns are the magnitude and duration of flow available for delta formation and the efficiency of the delta building process. The magnitude of flow that can be diverted depends on the impacts on other competing uses for the water, that is, navigation and water supply. Preliminary hydraulic analysis indicated that with a river flow of 300,000 cfs, the adverse impacts on navigation and water supply are minor with a diversion of 25,000 cfs, moderate with a diversion of 50,000 cfs, major with a diversion of 75,000 cfs, and severe with a diversion of 100,000 cfs. The magnitude of the flow in the river and the magnitude that is to be diverted affect the number of days in an average year that the water can be diverted. The number of days decreases as the magnitude of the diversion increases. For a river flow of 300,000 cfs, the number of days decreases from 270 days in an average year for a diversion of 25,000 cfs to 200 days a year for a diversion of 100,000 cfs.

The delta-building process was analyzed for a flow of 25,000 cfs and 100,000 cfs and for durations of 2, 7, and 20 years to provide a basis for identifying the magnitude and duration of flow required to maintain the

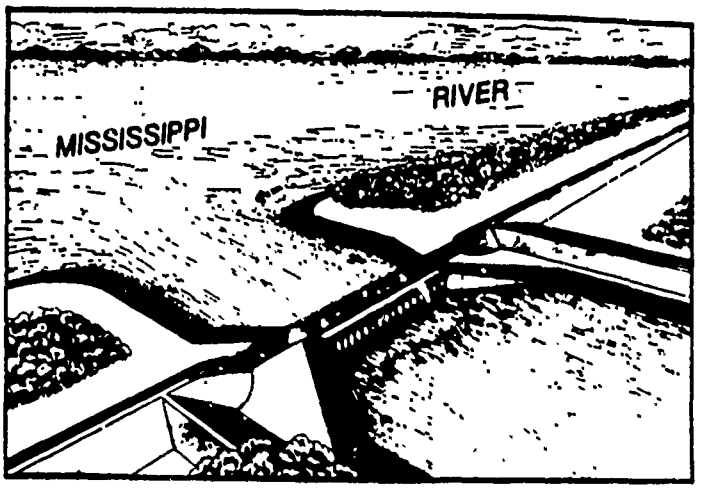


FIGURE 14. TYPICAL CONTROLLED SEDIMENT DIVERSION.

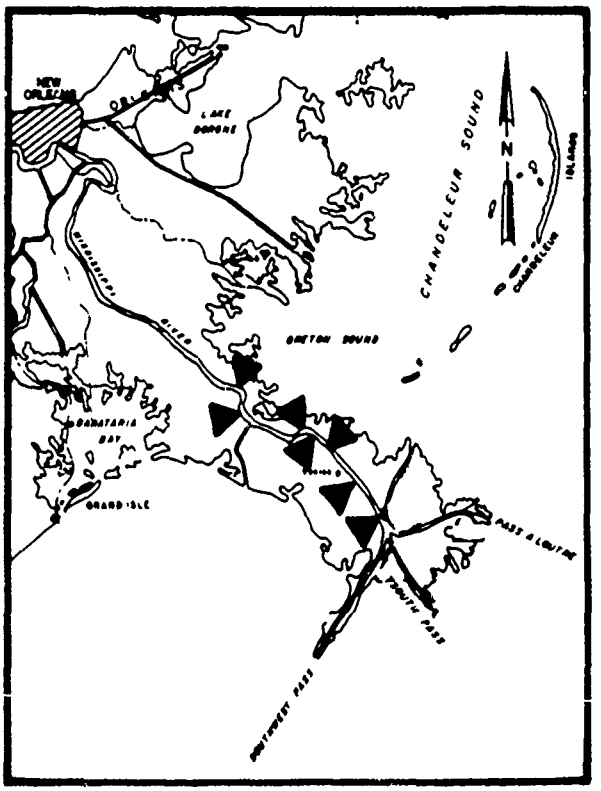


FIGURE 15. LOCATION OF CONTROLLED SEDIMENT DIVERSION SITES.

maximum rate of delta formation. The analysis indicated that the efficiency or rate of delta formation is most rapid in the first two years and decreases over time. The delta would be about 72 percent complete by the seventh year and nearly 100 percent complete by the 20th year. As the delta grows and matures, the flow and sediment transport through the delta slackens and, after the seventh year, the rate of delta formation decreases sharply. Operating two or more structures simultaneously would increase the total amount of land created, but the rate or efficiency of delta formation would decrease. A flow of 25,000 cfs would create 320 acres per year at an average cost per site of $11,727 per acre. A flow of 100,000 cfs would create 840 acres per year at an average cost per site of $12,110 per acre (Table 11).

A flow of 100,000 cfs would cause severe impacts on navigation, water supply, and fish and wildlife resources. These impacts have not been included in the per acre cost, but would increase the per acre substantially. Therefore, a flow of 100,000 cfs was eliminated from further consideration. Thus, the controlled diversion of a flow of 25,000 cfs for a duration of 7 years was retained to formulate plans to create marsh.

PLACE DREDGED MATERIAL

Material dredged from navigation channels or sediment-rich areas could be pumped to shallow water bodies to create marsh. This would contribute to preserving wetlands, enhancing vegetative growth, reducing erosion and saltwater intrusion, preserving the marsh's capacity to buffer hurricane flooding, preserving esthetic and ecologic attributes, improving commercial fish and wildlife production, and improving sport fish and wildlife opportunities. A major source of the material would be the 60 million cubic yards of dredged material excavated annually in the New Orleans District maintenance dredging program. The maintenance dredging history of 27 coastal navigation projects was analyzed to determine the volume of material available to build marsh and the proximity of the dredging to

TABLE 11

MARSH CREATION WITH CONTROLLED SEDIMENT DIVERSIONS

Site Location (River Mileage)[1]	Design Flow			
	25,000 CFS		100,000 CFS	
	Marsh Created (Acres/Year)	Cost Per Acre (Dollars/Acre)	Marsh Created (Acres/Year)	Cost Per Acre (Dollars/Acre)
Site 1 Mississippi River East Bank-Mi. 34.9	320	$ 7,884	840	$ 9,192
Site 2 Mississippi River West Bank-Mi. 31.3	320	15,412	840	14,314
Site 3 Mississippi River East Bank-Mi. 20.0	320	9,175	840	10,821
Site 4 Mississippi River West Bank-Mi. 16.4	320	17,325	840	15,942
Site 5 Mississippi River East Bank-Mi.	320	10,075	840	11,378
Site 6 Mississippi River West Bank-Mi. 9.5	320	10,856	840	11,400
Site 7 Mississippi River West Bank-Mi. 6.0	320	11,362	840	11,721

1/ Miles above Head of Passes

suitable marsh creation sites. As a result, eight projects that would yield sufficient quantities of dredged material on a regular basis to support marsh creation were identified:

- Calcasieu River and Pass
- Atchafalaya River - Bayou Chesse, Boeuf, and Black
- Lower Mermentau River
- Gulf Intracoastal Waterway
- Calcasieu River to Atchafalaya River
- Houma Navigation Canal
- Barataria Bay Waterway
- Mississippi River, Southwest Pass, and Baptiste Collette Pass, South Pass, and Tiger Pass
- Mississippi River-Gulf Outlet

The dredged material from these channels has the potential to create 43,000 acres of marsh over a period of 50 years at costs ranging from $700 to $4,100 per acre (Table 12). The cost of creating an acre of marsh depends on the distance the material is pumped and the quantity required to fill the receiving area. Thus, the eight navigation projects were retained for formulating plans.

Another source is the 13 million cubic yards of material excavated annually in the maintenance dredging program for navigation channels in Mississippi Sound and Mobile Bay. The dredged material from the navigation channels would be transported by hopper barges 25 to 85 miles (one way) to the Biloxi Wildlife Management Area in eastern St. Bernard Parish. The material would be removed by an unloading facility and pumped 2 to 5 miles inland to the marsh creation sites. The cost of marsh creation with this method varied with the distance the material was transported. The lowest cost for an acre of marsh was $97,000. Based on potential benefits, this method is clearly unjustified and was eliminated from further consideration.

TABLE 12

MARSH CREATION WITH DREDGED MATERIAL
FROM MAINTENANCE OF NAVIGATION PROJECTS

Parish/Navigation Project	Quantity (Cub. Yds/Yr)	Marsh Created (Acres/Yr)	Cost per Acre[1] (Dollars/Ac)
Cameron			
Calcasieu Ship Channel	1,100,000	80	$1,925
Gulf Intracoastal Waterway	220,000	33	1,000
Mermentau River	170,000	22	908
Vermilion			
Gulf Intracoastal Waterway	70,000	11	955
Iberia			
Gulf Intracoastal Waterway	130,000	20	975
St. Mary			
Gulf Intracoastal Waterway	110,000	16	1,031
Atchafalaya River, Bayous Chene and Bouef	870,000	80	1,740
Terrebonne			
Houma Navigation Canal	1,100,000	60	4,053
Jefferson			
Barataria Waterway	720,000	65	1,772
Plaquemines			
Southwest Pass	6,500,000	214	4,105
Tiger Pass	150,000	15	700
Baptiste Collette Pass	460,000	30	1,073
South Pass	200,000	20	700
St. Bernard			
Mississippi River - Gulf Outlet	1,050,000	100	840

1/ Based on incremental increase in maintenance dredging cost to create marsh.

A third source is material dredged from sediment-rich areas in the Mississippi River and nearshore gulf waters. A hydraulic dredge could remove bedload sediments from the Mississippi River and pump the material to the receiving area. One 27-inch hydraulic dredge operating year round could create 18,000 acres of marsh in a strip 1,500 feet wide over a period of 50 years. Four dredges could operate efficiently at the same time and create four strips of marsh totaling 72,000 acres. The cost of marsh creation with this technique was $11,000 per acre. This cost exceeds the potential benefits. Therefore, this method was eliminated from further consideration.

Cutterhead dredges could remove material from a strip parallel to the Mississippi River-Gulf Outlet and a strip parallel to the shoreline of marshes in Chandeleur Sound. The material would be pumped 1 to 25 miles inland to marsh creation sites in eastern St. Bernard Parish. Dredges could also be located in the nearshore gulf waters off Bayou Lafourche and Timbalier Islands and could pump the material 5 to 35 miles inland to marsh creation sites in Lafourche and Terrebonne Parishes. One dredge operating year-round could create 17,000 acres of marsh over a 50-year period. The cost of marsh creation varied with the distance the material was pumped. The lowest cost was $22,000 per acre, which exceeds the potential benefits. Therefore, the method was eliminated from further consideration.

Placing dredged material is presently being implemented to a limited extent by the U.S. Army Corps of Engineers. About 3,000 acres of marsh have been created with material from the maintenance dredging of the Mississippi River Southwest Pass and several other navigation channels.

INJECT LIQUIDS INTO SUBSURFACE STRATA

Liquids could be injected into subsurface strata to reduce the rate of subsidence, a prime cause of land loss. This would reduce marsh losses due to compaction, subsidence, and saltwater intrusion. Injection wells are

widely used in the petroleum industry for by-products disposal and secondary recovery of oil. Most often, production wells are simply converted to injection wells when the pressures in the producing strata drop to a critical level. Depending on formation characteristics, one or more injection wells may be used to raise the pressure. The State of California requires oil companies to address the problem of subsidence resulting from withdrawals from oil-bearing strata and take appropriate corrective measures, including injection. This method might be effective in localized areas with favorable geologic conditions, but may not be effective on a regional basis. Therefore, this method will not be considered further. But, is should be considered by the appropriate Federal and state regulatory agencies that could provide incentives through the permitting process to petroleum companies to reinject liquids for the purpose of maintaining pressures in producing strata.

REGULATE ALTERATION OF WETLANDS

Regulating the alteration of wetlands would make contributions to their preservation, reduce saltwater intrusion, preserve some of the marsh capacity to buffer hurricane flooding, and preserve esthetic and ecologic attributes and cultural heritage. Federal, state, and local agencies have recognized the importance of this measure in preserving and protecting the environ-ment. These agencies have implemented numerous regulatory programs to protect the public interest. The U.S. Army Corps of Engineers administers a major regulatory program under authorities in Sections 9, 10, and 13 of the River and Harbor Act of 1899; Section 404 of the Clean Water Act of 1972, as amended; and Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972, as amended. The U.S. Environmental Protection Agency, Department of Commerce, and Department of the Interior also administer regulatory programs. In addition, the State of Louisiana has an approved coastal resources program that regulates development in the coastal zone. The program is administered by the state and parish governments. The Federal, state, and local regulatory programs are comprehensive and intended to regulate alteration of the wetlands.

Continued administration of these programs will aid in meeting study objectives. The regulatory agencies could require permit applicants to offset marsh loss by creating marsh in the permit area or another area. The permitting agencies could identify areas requiring remedial action and how urgently the action is needed.

PLAN FORMULATION RATIONALE

Controlled and uncontrolled sediment diversions and placement of dredged material from the maintenance of navigation channels are the specific measures used to formulate plans for marsh creation. The measures were combined to form plans to address the problems and needs in the parishes of St. Bernard, Plaquemines, Jefferson, Terrebonne, St. Mary, Iberia, Vermilion, and Cameron.

Combining the seven controlled diversion sites with various flows of different durations could produce numerous plans. However, it was assumed that all seven sites would be built. Thus, in formulating plans the major concerns were the magnitude and duration of the flows, and the impacts on navigation and water supply, and the fishery resources. Diverting a flow of 25,000 cfs would cause the least impacts. This substantially reduces the number of possible sediment diversion alternatives. The only remaining concerns are the duration and when each structure in a plan should begin operation. A plan that requires the flow to be diverted for a two-year duration at each site in sequence, and the sequence repeated until marsh is created at all seven sites, would necessitate construction of the seven sites in the first 12 years. This would be more costly than constructing the sites at seven-year intervals. Thus, it appears that a sediment diversion plan should have only one structure operating for seven years at any given time. The sequential ordering could be based on hydraulic efficiency; efficiency decreases downriver. The ordering could also be done on the basis of the least to the most costly, but alternating from the least costly on one bank to the next most costly on the opposite bank to minimize impacts. These conditions substantially reduced the combinations that could be used to formulate plans to create marsh with sediment diversion.

New Orleans District has used material from maintenance dredging of navigation projects to create marsh. The cost of creating marsh with this technique increases proportionally with the distance the material must be transported and the amount of material required to fill open water areas to create marsh.

DESCRIPTION OF PRELIMINARY PLANS

A total of four alternative plans were investigated in the initial planning effort. The marsh creation alternatives would affect most of the planning objectives; the effectiveness, contribution to the planning objectives, and the impacts vary. The no-action alternative was also identified and will be retained throughout the planning process to provide a basis for comparing the action measures. The alternative plans investigated are described in Table 13.

PRESENTATION AND ASSESSMENT OF PRELIMINARY PLANS

The adverse and beneficial impacts associated with each plan are related to the measures employed to create marsh. Each measure produces construction and operational impacts. The direct construction impacts include the conversion of terrestrial and aquatic habitats to channels, levees, and dredged material disposal areas. The primary operational impacts are associated with abrupt changes in salinity gradients, hydraulic regime and sedimentation patterns, decrease in water temperatures, and an increase in coliform bacteria and pollutants. The major quantifiable differences in the impacts are related to the area of introduction, the acres required for construction, and the size of the area affected by the water and sediment plume. Therefore, the impacts that are common to each measure will only be discussed in a general manner here, but the specific differences will be presented with each plan. All plan benefits and costs are based on October 1983 prices and were evaluated using the current interest rate of 8 3/8 percent and a 50-year project life.

TABLE 13

ALTERNATIVE PLANS FOR MARSH CREATION

Alternative - Parish	Description of Plan
1A - Plaquemines, St. Bernard, and Jefferson Parishes	Place material dredged from Mississippi River-Gulf Outlet along east bank marshes. Divert 25,000 cfs for a seven-year duration at each site, successively at Sites 1, 2, 3, 4, 5, 6, and 7. Breach or crevasse distributaries at five locations. Place material dredged from Mississippi River, Southwest Pass, Baptiste Collette Pass, South Pass, and Tiger Pass in adjacent open water areas. Place material dredged from Barataria Waterway, Dupre Cut, in confined water bodies along both banks.
1B - Plaquemines, St. Bernard, and Jefferson Parishes	Place material dredged from Mississippi River-Gulf Outlet along east bank marshes. Divert 25,000 cfs for a seven-year duration at each site, successively at Sites 1, 6, 3, 7, 5, 2, and 4. Breach or crevasse distributaries at five locations. Place material dredged from Mississippi River, Southwest Pass, Baptiste Collette Pass, South Pass, and Tiger Pass in adjacent open water areas. Place material dredged from Barataria Bay Waterway, Dupre Cut, in confined water bodies along both banks.
2 - Terrebone Parish	Place material dredged from Houma Navigation Canal inland reach in open water bodies along both banks.
3 - Cameron, St. Mary, Iberia, and Vermilion Parishes	Place material dredged from Atchafalaya River, Bayou Chene in Avoca Island area. Place material dredged from Gulf Intracoastal Waterway in 14 areas along south bank. Place material dredged from Mermentau River in Mud Lake. Place material dredged from Calsasieu Ship Channel, Calcasieu Lake reach, at eight locations along the west and south sides of Calcasieu Lake.
4 - Coastwide	No action.

Dredging and placing material to create marsh produces impacts in the dredged area as well as the disposal area. An important aspect of using dredged material is the ability to regulate placement of the material. Adverse impacts can be minimized by placing the material in open water bodies or water bodies semi-confined with dikes. The water released with the dredged material will decrease salinities in the immediate disposal area. Regulation of the outflow will minimize adverse impacts. After placement is complete, the dikes would be breached to allow development of natural drainage. An important, but short-term impact is increased turbidity in the dredging and disposal area. The turbidity reduces light penetration and will cause a temporary decrease in photosynthesis and primary productivity. The major adverse impacts are the destruction of benthic organisms and their habitat. Most free-swimming organisms such as finfish, crabs, and shrimp can generally escape the turbid areas. However, the slow-moving and sessile organisms will be killed by passage through the dredge or by rapid burial. Some large molluscs and polychaetes are able to burrow upward and escape when covered by 12 to 16 inches of material. In most cases, recolonization of benthic communities in the dredged and disposal areas will be fairly rapid, generally less than six months. Filling the open water areas will permanently displace some important commercial and recreational finfish and shellfish. However, these losses are more than offset by the increase in productive marsh acreage and improved production of fish and wildlife.

The uncontrolled sediment diversions will affect the project site and a large receiving area. The diversions will be accomplished by breaching the natural river bank. In general, the breach will be 20-feet deep over a bottom width of 80 feet and extend 50 to 200 feet from the distributary to the receiving water body. Three of the sites are located in the Delta National Wildlife Refuge and the other two sites are within the state-owned Pass a Loutre Waterfowl Management Area. An oil company created a crevasse near the site on Octave Pass as a mitigative measure. A similar crevasse

is planned near the site on Raphael Pass. The major adverse impacts are related to filling open water areas and displacing benthic organisms. However, the losses will be offset by improved habitat conditions and fish and wildlife production.

The controlled diversion facilities include a control structure and an outflow channel. The control structure consists of a series of box culverts built into the levee. Table 14 presents a summary of the pertinent engineering features of the diversion facilities. The major construction impacts are related to the conversion of terrestrial and aquatic habitats to the channels and levees required by the controlled diversions. The channels will be excavated by dragline or hydraulic dredge. Excavated material will be used to construct levees at Sites 2 and 4 where the channel passes through developed areas. Excess material will be placed in open water areas to create marsh. The major adverse impacts are associated with the introduction of a flow of 25,000 cfs for about 270 days a year. The diverted sediment-laden water is cool and contains heavy metals, pesticides, phenols, and fecal coliform bacteria. Diversions have the potential to overfreshen thousands of acres of prime oyster-growing areas in the bays bordering each bank of the river. If the oysters survived overfreshening and siltation, they would not be harvestable due to pollution. Estuarine organisms requiring higher salinities would be displaced for extended periods. The majority of the sediments and pollutants will be deposited in the receiving water bodies, but the fresh water plume with the suspended sediments, pollutants, and fecal coliform bacteria will disperse through the maze of interconnected waterways, affecting several thousand acres. The cool river water will decrease water temperatures in the receiving water bodies for the first six months of the year. The water quality impacts will be most severe in the brackish and saline marshes above mile 20 and less severe in the fresh-intermediate marshes below mile 20 that are influenced by the river. The adverse impacts on oyster-growing areas and nursery areas used by estuarine-dependent species may outweigh the benefits of marsh creation

TABLE 14

SUMMARY OF PERTINENT ENGINEERING FEATURES OF CONTROLLED SEDIMENT DIVERSION FACILITIES WITH A FLOW OF 25,000 CFS

Location (River Mileage)[1]	Culverts		Channel	Land Requirements (Acres)	Habitat Type
	Number	Height, Width, Length (Feet)	Depth, Width, Length (Feet)		
Site 1 (Mi 34.9)	10	20 x 20 x 75	19 x 480 x 3,500	70	Scrub-Shrub & Marsh
Site 2 (Mi 31.3)	10	20 x 20 x 75	19 x 480 x 2,000	80	Residential & Agricultural
Site 3 (Mi 20.0)	13	20 x 20 x 75	19 x 480 x 3,500	40	Marsh
Site 4 (Mi 16.4)	14	20 x 20 x 75	19 x 480 x 2,500	95	Residential & Agricultural
Site 5 (Mi 15.0)	14	20 x 20 x 75	19 x 480 x 3,500	40	Marsh
Site 6 (Mi 9.5)	15	20 x 20 x 75	19 x 480 x 2,500	99	Marsh
Site 7 (Mi 6.0)	16	20 x 20 x 75	19 x 480 x 2,500	99	Marsh

1/ Miles above Head of Passes

when viewed on a short-term basis during the years of diversion. Over the long-term, a revitalized habitat should improve fish and wildlife production. The benefits attributed to creating marsh at the seven sites are $23,520,000. The average annual costs and benefits are $26,269,000 and $3,636,000, respectively (See Table 15). The average cost of marsh creation for the seven sites is $11,727 per acre. Losses due to overfreshening the prime oyster grounds at Sites 1, 2, 3, and 4 have not been determined but could exceed $12 million annually for 14 years. Creating marsh will produce some short-term monetary losses that, to the oyster and other fisheries, could outweigh the benefits at Sites 1, 2, 3, and 4. The losses can be minimized by controlling water movements or relocating oyster lease holders to adjacent areas. However, over the long-term, marsh creation will be beneficial. Calculating the value of a newly created acre of marsh is a difficult problem. The value of an acre of marsh as a producer of fish and wildlife and as real estate has been estimated at $1,500 per year. Placing a value on the other aspects of the marsh as a buffer against hurricane-induced flooding and a repository for agricultural and domestic wastes, and on the marsh's esthetic, ecologic, and cultural attributes is extremely difficult. But, assigning a dollar value to these aspects of the marsh will increase the value of an acre of marsh significantly.

PLAQUEMINES, ST. BERNARD, AND JEFFERSON PARISHES ALTERNATIVE PLANS

The St. Bernard Parish element of Plans 1A and 1B provides for creating 5,000 acres of marsh with material obtained from the maintenance dredging of the Mississippi River-Gulf Outlet. Approximately 1,050,000 cubic yards of material are dredged annually from the MR-GO inland reach. This material would be pumped 1 to 5 miles eastward to semi-confined water bodies and placed to an elevation for creating marsh. The dredged material will create about 100 acres of brackish marsh. Based on the incremental increase in maintenance dredging costs estimated at 8 cents per cubic yard, the cost of marsh creation is estimated at $840 per acre. Over a 50-year

TABLE 15

COSTS AND BENEFITS OF MARSH CREATION WITH CONTROLLED SEDIMENT DIVERSIONS OF 25,000 CFS AT SITES ALONG MISSISSIPPI RIVER EAST (E) AND WEST (W) BANKS ABOVE HEAD OF PASSES

Item	Site 1 (Mi 34.9 E)	Site 2 (Mi 31.3 W)	Site 3 (Mi 20.0 E)	Site 4 (Mi 16.4 W)	Site 5 (Mi 15.0 E)	Site 6 (Mi 9.5 W)	Site 7 (Mi 6.0 W)	Total
Real Estate	$ 119	$ 846	$ 107	$ 1,981	$ 114	$ 275	$ 176	$ 3,618
Relocations*	400	12,600	400	8,800	400	0	0	22,600
Channel & Levees	2,040	3,860	3,500	6,800	3,900	4,200	4,500	28,800
Structure*	11,460	10,140	12,300	13,200	13,500	14,800	15,500	90,900
TOTAL COST	$14,019	$27,446	$16,307	$30,781	$17,914	$19,275	$20,176	$145,918

* Includes contingencies (25%+), Engineering & Design (11%+), and Supervision & Administration (11%+).

BENEFIT-COST ANALYSIS[1] ($000)[1]

Average Annual Cost	$ 2,523	$ 4,932	$ 2,936	$ 5,544	$ 3,224	$ 3,474	$ 3,636	$26,269
Average Annual Benefits	480	480	[illegible]	480	480	480	480	3,636
Benefit/Cost Ratio	0.19	0.1[illegible]	[illegible]6	[illegible]09	0.15	0.14	0.13	0.13

1/ Losses due to overfreshening of [illegible]er [illegible]ng [illegible]t determined but could exceed $12 million annually at sites 1, 2, 3, and [illegible]

period, approximately 5,000 acres of marsh would be created at a first cost of $4,200 and an average annual cost of $84,000. The average annual monetary benefits attributed to creating this marsh are estimated at $150,000 per year. The benefit-to-cost ratio is 1.8 to 1.

The Plaquemines Parish element of Plans 1A and 1B provides for the creation of 39,480 acres of marsh by placing dredged material and sediment diversions. Approximately 7,310,000 cubic yards of material are excavated by hydraulic cutterhead dredge annually from the Mississippi River, Southwest Pass, Baptiste Collette Pass, South Pass, and Tiger Pass. The material would be pumped 1 to 5 miles beyond the banks into open water bodies to create about 279 acres of fresh marsh per year. The incremental increase in maintenance dredging costs is estimated at 7 to 12 cents per cubic yard. The cost of marsh creation is estimated at $3,352 per acre. Over a 50-year period, approximately 13,950 acres of marsh would be created at a first cost of $46,760,000 and an average annual cost of $935,200. The average annual benefits are estimated at $418,500. The benefit-cost ratio is 0.45 to to 1.

The Plaquemines Parish element includes five uncontrolled diversions along the river's distributaries that would create on the average about 104 acres of marsh per year. The rate would be higher initially and would decrease over time. To maintain a satisfactory rate of marsh creation, the breach would have to be reopened, extended, or relocated every two or three years. The cost of marsh creation is estimated at $1,200 per acre. Over a 50-year period, about 5,200 acres of marsh would be created at a first cost of $6,240,000 and an average annual cost of $124,800. The average annual benefits are estimated at $156,000. The benefit-cost ratio is 1.2 to 1.

Plans 1A and 1B also include controlled diversions to create marsh at seven sites. Sedimentation at one site would create abo[illegible] acres of fresh marsh per year and 2,240 acres in seven years. Over a 50-year period at the seven sites, a total of 15,680 acres of fresh marsh would be created at

an average cost of $11,727 per acre. The average annual costs and benefits are presented in Table 15. The major differences between Plans 1A and 1B are related to the strategy followed in diverting the water. The plans provide for diverting the flow at a site until a delta is built and delta formation becomes inefficient (about seven years). The structure would then be closed and diversion would begin at another site in the sequence until marsh has been created at all seven sites.

The diversion strategy for Plan 1A is based on hydraulic efficiency. The diversion would be initiated at Site 1 on the east bank of the river and when completed, it would be moved to the next site downriver on the opposite bank. Then the diversion would be moved successively to Site 2 on the west bank, Site 3 on the east bank, Site 4 on the west bank, Site 5 on the east bank, Site 6 on the west bank, and finally to Site 7, also on the west bank. The diversions above mile 20 could cause adverse impacts on the oyster growing areas in the bays bordering the river. However, one of the attributes of Plan 1 is that the diversion would alternate between the east and west banks of the river. During the intervening years of no discharge, estuarine organisms could reestablish themselves. The improved environmental conditions would increase the productivity of the important commercial and recreational fish and wildlife species, and would limit the losses in the oyster fishery to the seven years of diversion at a particular site. Thus, the prime oyster growing areas at Sites 1 and 3 on the east bank and Sites 2 and 4 on the west bank would be adversely impacted for only 14 years of the 50-year life of the project.

The diversion strategy for Plan 1B is based mostly on economics. Construction would begin with the least costly structure on one bank and would proceed in the following sequence to the next most costly on the opposite bank until all seven structures were built: Site 1 on the east bank, Site 6 on the west bank, Site 3 on the east bank, Site 7 on the west

bank, Site 5 on the east bank, Site 2 on the west bank, and finally Site 4, also on the west bank. This plan offers the same type of beneficial alteration of flows as Plan 1, but the more costly sites would be scheduled for construction further in the future. This would reduce the present worth of the construction.

The Jefferson Parish element of Plans 1A and 1B employs the use of material dredged from the Barataria Waterway, Dupre Cut, to create 3,200 acres of brackish marsh. Approximately 720,000 cubic yards are excavated annually from the Dupre Cut. The material would be pumped 1 to 5 miles to semi-confined water bodies on each side of the waterway to create about 65 acres of brackish marsh each year. Based on the incremental increase in the maintenance dredging cost estimated at 16 cents per cubic yard, the cost of marsh creation would be $1,772 per acre. Over a 50-year period, approximately 3,250 acres of marsh would be created at a first cost of $5,759,000 and an average annual cost of $115,200. The average annual benefits are estimated at $97,500. The benefit-cost ratio is 0.85 to 1.

TERREBONNE PARISH ALTERNATIVE PLAN

Plan 2 involves the use of material dredged from the Houma Navigation Canal (HNC) to create 3,000 acres of fresh-intermediate and brackish marshes. Approximately 1,100,000 cubic yards of material are excavated annually from the HNC. The material would be pumped 1 to 5 miles to semi-confined water bodies on each side of the HNC to create about 60 acres of marsh each year. Based on the incremental increase in the maintenance dredging cost estimated at 22 cents per cubic yard, the cost of marsh creation is estimated at $4,053 per acre. Over a 50-year period, approximately 3,000 acres of marsh would be created at a first cost of $12,100,000 and an average annual cost of $243,200. The average annual benefits are estimated at $70,000. The benefit-cost ratio is 0.29 to 1.

CAMERON, ST. MARY, IBERIA, AND VERMILION PARISHES ALTERNATIVE PLANS

The St. Mary Parish element of Plan 3 provides for the creation of 4,800 acres of fresh-intermediate and brackish marshes with material dredged from the Atchafalaya River, Bayou Chene in the Avoca Island area, and the GIWW. About 980,000 cubic yards are excavated annually from these sections of the waterways in the parish. The material would be pumped 1 to 5 miles to semi-confined water bodies to create about 96 acres of marsh each year. Based on an incremental increase in the maintenance dredging cost estimated at 15 to 16 cents per cubic yard, the cost of marsh creation is estimated at $1,622 per acre. Over a 50-year period, about 4,800 acres of marsh would be created at a first cost of $7,785,000 and an average annual cost of $155,700. The average annual benefits are estimated at $144,000. The benefit-cost ratio is 0.92 to 1.

The Iberia-Vermilion Parish element of Plan 3 involves the use of material dredged from sections of the GIWW to create 1,000 acres of fresh-intermediate marsh. Approximately 200,000 cubic yards of material are excavated annually from sections of the waterway in the parish. The material would be pumped 1 to 4 miles to open water areas on the south bank to create 31 acres of marsh each year. Based on the incremental increase in the maintenance dredging cost estimated at 15 cents per cubic yard, the cost of marsh creation is estimated at $968 per acre. Over a 50-year period, about 1,550 acres of marsh would be created at a first cost of $1,500,000 and an average annual cost of $30,000. The average annual benefits are estimated at $46,500. The benefit-cost ratio is 1.6 to 1.

The Cameron Parish element of Plan 3 provides for the creation of 6,750 acres of fresh-to-saline marshes with material dredged from sections of the GIWW, the Calcasieu Ship Channel, and the Mermentau River in the parish. About 1,490,000 cubic yards of material are dredged annually from sections of these waterways. The material will be pumped 1 to 5 miles to open water areas to create 135 acres of marsh each year. Based on the incremental

increase in the maintenance dredging cost estimated at 14 to 15 cents per cubic yard, the cost of marsh creation is estimated at $1,533 per acre. Over a 50-year period, approximately 6,750 acres of marsh would be created at first cost of $10,348,000 and an average annual cost of $207,000. The average annual benefits are estimated at $202,500. The benefit-cost ratio is 0.99 to 1. Plan 4 has an overall average annual cost of $382,200 and average annual benefits of $376,500.

CONCLUSION

This initial evaluation study confirmed that Louisiana is losing its coastal marshes at an alarming rate because of natural forces--compaction, subsidence, sea level rise, saltwater intrusion, and erosion--and because of man's activities.

In the course of the study, a range of alternatives to create marsh was developed. Whether or not the plans are justified for Federal implementation depends on the dollar value of the marsh. The value of the marsh as real estate and as a producer of commercial and recreational fish and wildlife was used in the economic analysis. But, this is only a portion of the true value of the marsh.

Louisiana values the marsh for its unique esthetic and ecologic characteristics and its priceless cultural resources, as a repository for domestic and agricultural waste discharges, and for its capacity to buffer hurricane-induced flooding. These aspects of the marsh have tremendous value that must be considered in calculating the benefits of any of the alternative plans. However, these so-called "intangible benefits" were not valued in dollars and cents for this initial evaluation. Therefore, I conclude that the question of the monetary value of the marsh's intangible benefits should be resolved so that the marsh's true value can be used in determining the economic feasibility of an alternative plan.

Another significant problem identified in the course of the study was the lack of data. Data on subsidence is sparse and substantially more is needed to project subsidence rates and relate them to erosion and flooding. To predict future conditions in the coastal area, the hurricane flood threat should be reanalyzed and possibly revised. More detailed analysis and verification of the land loss rates and shoreline changes are needed. Therefore, I also conclude that the hurricane flooding problem should be analyzed in order to develop and justify solutions.

I have concluded from our initial evaluation studies that marsh creation with material from maintenance dredging in the eight navigation channels and five uncontrolled sediment diversions appear to be economically justified and should be investigated in greater detail in a feasibility study. During the study, the other alternatives of controlled diversions from the Mississippi River and transporting material from the Mississippi River to nearby subsiding areas should also be further analyzed in detail.

REQUIREMENTS FOR FURTHER STUDY

This initial evaluation provides the basis to evaluate the merits of continuing the study of the identified problem areas. In the next phase, feasibility studies would be conducted that would result in a report with recommendations to Congress. The initial evaluation identified three problem areas for which additional studies are warranted. The problem areas extend across coastal Louisiana in several different parishes. Detailed study of each problem area would probably be accomplished on separate time schedules and in cooperation with different local sponsors. Therefore, in the interest of expediting the high priority studies and not being delayed by the slower-moving ones, the detailed studies have been divided into three interim feasibility investigations. A separate report will be prepared for each problem area. A more detailed level of analysis

will be undertaken in the feasibility phase to determine economic feasibility and to address engineering and environmental concerns more completely. All studies will be conducted in accordance with applicable Federal policies, guidelines, and regulations.

ECONOMIC STUDIES

Economic base studies focusing on gulf-wide marsh acreages and related fishery and recreational outputs will be required to fully evaluate nonmarket NED contributions of the wetlands. Marshland outputs in the categories of storm surge reduction and tertiary waste treatment will also be investigated as well as changes in relative price levels for marsh outputs. Real estate estimates for specific project sites will be developed. Projections of all important variables identified above will be required for the 50-year project life, both with and without proposed solutions.

ENGINEERING STUDIES

Hydrologic and hydraulic studies, including analyses of flow frequencies, rainfall-runoff relationships, saltwater intrusion, and projections of marsh creation, will be conducted to evaluate the effectiveness of alternative plans. Topographic surveys will be made to ascertain characteristics of potential marsh creation areas. Soil boring and testing will be used to determine potential subsidence in selected areas.

General design studies and cost estimates for each alternative will be prepared. The general design studies will involve determining real estate requirements, relocation requirements, structural designs, geometric channel layouts, dredged material placements, embankment designs and layouts, access road locations, seepage studies, and bank protection requirements. Cost estimates will require the quantification of construction materials and related items for each alternative plan and will

be based on unit costs applicable to the study area. Cost estimates for nonstructural features of the alternatives will be developed.

ENVIRONMENTAL STUDIES

Additional studies are needed to properly examine environmental impacts. Studies will be performed to obtain the biological data needed to prepare an Environmental Impact Statement. The U.S. Fish and Wildlife Service, in coordination with the New Orleans District, will identify significant resources and quantify environmental impacts on these resources. Further coordination and synthesis of information from various Federal, state, and local agencies will be necessary. Land use and habitat losses will be identified, quantified, and translated into environmental and economic impacts. In addition, the results of environmentally related studies from hydrology would be analyzed and incorporated into the impact statement. Endangered species assessments, 404(b)(1) Evaluations, and coastal zone management (CZM) consistency determinations will also be prepared. Cultural resources and recreational needs and opportunities will be developed so that physical and economic impacts can be identified.

STUDY PARTICIPATION AND COORDINATION

An essential part of the planning process is the participation of and coordination with the public and Federal, state, and local agencies. During the study, an effort was made to promote two-way communication between study planners and local, state, and Federal officials and the public. Avenues of public involvement included public notices, interagency meetings, formal and informal contacts through correspondence, special topic meetings, and public meetings.

The original public meetings for the parent study were held in Jennings, Houma, and New Orleans, Louisiana, in November and December 1968. Local interests expressed concern about a number of issues including land loss.

A notice of study initiation was mailed in October 1983 to Federal, state, and local agencies and officials, local libraries, news media, post offices, environmental groups, industries, and interested individuals. The notice outlined the study purpose and asked that any comments or suggestions pertaining to this study be submitted.

Several meetings have been held with local interests. Two interagency meetings were held to discuss the status and future direction of the study. Representatives of the U.S. Fish and Wildlife Service, Minerals Management Service, Soil Conservation Service, the Louisiana Departments of Natural Resources, Geological Survey and Coastal Management Section, Wildlife and Fisheries, and Health and Human Resources, the academic community, and several parishes attended the meetings. In December 1983, representatives of the U.S. Army Corps of Engineers Waterways Experiment Station (WES) were invited to give a presentation on WES techniques in erosion control and marsh creation. Local parish officials, academicians, state representatives, and agency officials attended the meeting held in the New Orleans District.

Public meetings were held in Belle Chasse, Houma, and Cameron, Louisiana, in late August 1984. Initial evaluation study results were discussed and local concerns and ideas obtained. Future study objectives were also discussed.

Most agencies or individuals voiced support for the study. Concerns were expressed for the lengthy process that must be followed before a Federal project is constructed and for the inadequacy of the worth calculation for an acre of marsh. Letters concerning this study and the USFWS Planning Aid Report are in the appendix to this report.

STUDY COST AND SCHEDULE

Three problem areas are scheduled for more detailed studies. Interim reports are to be prepared for Plaquemines, St. Bernard, and Jefferson

Parishes, Terrebonne Parish, and Cameron, St. Mary, Iberia, and Vermilion Parishes. The total study cost is $2,420,000 as shown in Table 16. One possible funding schedule is shown in Table 17. Copies of the PB-6's for the three interims are given in Plate 1 through 4.

A typical bar chart for the Plaquemines, St. Bernard, and Jefferson Parish Interim Study is shown in Table 18. Major schedule dates for the Plaquemines Parish study are:

Draft Report and PDEIS to LMVD	DEC 86
DEIS to EPA	MAY 87
Public Meeting	JUN 87
Feasibility Report and FEIS to LMVD	SEP 87

TABLE 16

ESTIMATED STUDY COST

Initial Evaluation	$400,000
Interim Studies	
Plaquemines, St. Bernard, and Jefferson Parishes	700,000
Terrebonne Parish	600,000
Cameron, St. Mary, Iberia, and Vermilion Parishes	720,000
Total Study Cost	$2,420,000

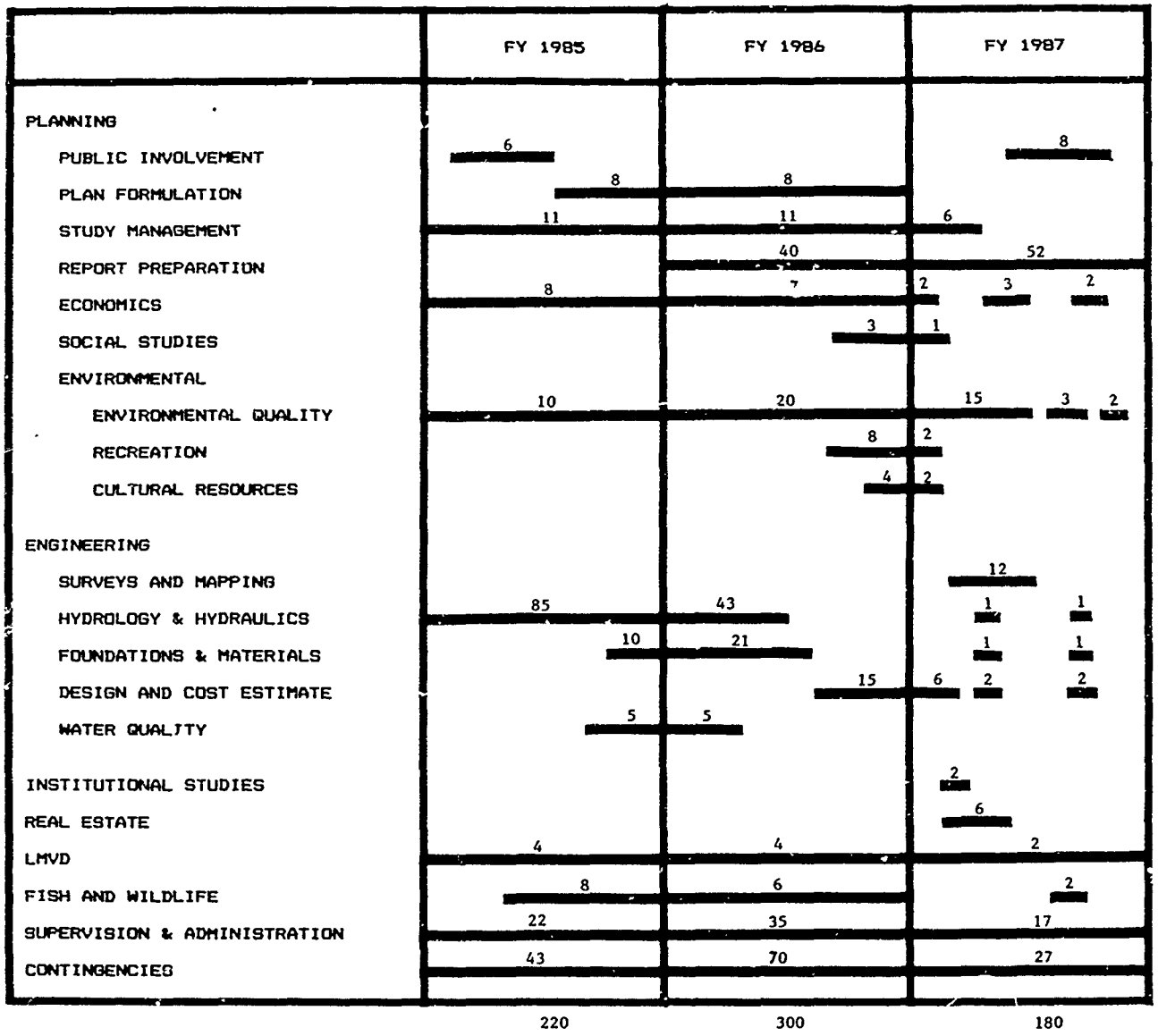
TABLE 17

STUDY SCHEDULE ASSUMING 50 PERCENT
COST SHARING WITH NONFEDERAL INTERESTS
(000'S)

	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	TOTAL
Plaquemines, St. Bernard, and Jefferson Parishes	110	150	90				350
Terrebonne Parish			130	100	70		300
Cameron, St. Mary, Iberia, and Vermilion Parishes				120	150	90	360
Total Federal	110	150	220	220	220	90	1,010

TABLE 18

INTERIM REPORT ON PLAQUEMINES, ST. BERNARD AND JEFFERSON PARISHES



RECOMMENDATION

Approval of this initial evaluation report is recommended.

Eugene S. Witherspoon
Colonel, Corps of Engineers
District Engineer

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RCS: DAEN-CWB-12

STUDY COST ESTIMATE (FB-6)
($000)
For use of this form, see ER 11-2-220

APPROPRIATION TITLE: General Investigations

CATEGORY: Surveys

CLASS: Flood Damage Prevention

NAME OF STUDY: Louisiana Coastal Area, LA Interim Report on Land Loss and Marsh Creation 61610B

SUBCLASS:

LINE NO.	SUBACCOUNT NUMBER	SUBACCOUNT TITLE	CURRENT COST ESTIMATE: RECONNOISSANCE PHASE	CURRENT COST ESTIMATE: FEDERAL FEASIBILITY PHASE	CURRENT COST ESTIMATE: NON-FEDERAL FEASIBILITY PHASE	CURRENT COST ESTIMATE: TOTAL FEASIBILITY PHASE	PREVIOUS FEDERAL COST ESTIMATE AND DATE APPROVED ( )	REMARKS
	a	b	c	d	e	f	g	h
1	61610B	Parent Study	400					Total Study Cost- 2020
2		Interim on Plaquemines, St. Bernard and Jefferson Parishes				700		
3		Interim on Terrebonne Parish				600		
4		Interim on Cameron, St. Mary Iberia and Vermilion Parishes				720		
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								

DATE PREPARED

DIVISION

DISTRICT

REGION

BASIN

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PLATE 1

ENG FORM 2204-R, May 82

REPLACES ENG FORM 2204, APR 77 WHICH IS OBSOLETE.

* U.S. Government Printing Office : 1982 - 522-097/364

RCS: DAEN-CWB-12

STUDY COST ESTIMATE (PB-6)
($000)
For use of this form, see ER 11-2-220

APPROPRIATION TITLE: General Investigations
CATEGORY: Surveys
CLASS: Flood Damage Preventions

NAME OF STUDY: Louisiana Coastal Area, LA Interim Report on Plaquemines, St. Bernard and Jefferson Parishes
SUBCLASS:

LINE NO.	SUBACCOUNT NUMBER	SUBACCOUNT TITLE	CURRENT COST ESTIMATE: RECONNOISSANCE PHASE	FEDERAL FEASIBILITY PHASE	NON-FEDERAL FEASIBILITY PHASE	TOTAL FEASIBILITY PHASE	PREVIOUS FEDERAL COST ESTIMATE AND DATE APPROVED ( )	REMARKS
	a	b	c	d	e	f	g	h
1	.00	Cost through 30 Sept 78				0		Total Study Cost $700,000
	.01	Public Involvement				14		
2	.02	Institutional Studies				2		
	.03	Social Studies				4		
3	.04	Cultural Resources				6		
	.05	Environmental Quality				50		
4	.06	U.S. Fish and Wildlife Service				16		
	.07	Economic Studies				22		
5	.08	Surveys and Mapping				12		
	.09	Hydrology and Hydraulics				30		
6	.10	Foundations and Materials				33		
	.11	Design and Cost Estimates				25		
7	.12	Real Estate				6		
	.13	Study Management				28		
8	.14	Plan Formulation				16		
	.15	Report Preparation				92		
9	.20	Other Studies Water Quality				10		
10		Recreation LMVD				10 10		
11	.31	Supervision and Administration				74		NOTE: Study Costs are included in the latest PB for for the parent study, however, they were not broken out by individual item.
12		Subtotal				560		
13		Contingencies Total				140 700		
14								

DATE PREPARED: 30 Sept 84
DIVISION: Lower Mississippi Valley
DISTRICT: New Orleans
REGION: Lower Mississippi
BASIN: Coastal Louisiana
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PLATE 2

ENG FORM 2204-R, May 82
REPLACES ENG FORM 2204, APR 77 WHICH IS OBSOLETE.

* U.S. Government Printing Office : 1982 - 522-097/364

RCS: DAEN-CWB-12

STUDY COST ESTIMATE (PB-6)
($000)
For use of this form, see ER 11-2-220

APPROPRIATION TITLE: General Investigations
CATEGORY: Surveys
CLASS: Flood Damage Preventions

NAME OF STUDY: Louisiana Coastal Area, LA Interim Report on Terrebonne Parish
SUBCLASS:

LINE NO.	SUBACCOUNT NUMBER	SUBACCOUNT TITLE	CURRENT COST ESTIMATE: RECON-NOISSANCE PHASE	FEDERAL FEASIBILITY PHASE	NON-FEDERAL FEASIBILITY PHASE	TOTAL FEASIBILITY PHASE	PREVIOUS FEDERAL COST ESTIMATE AND DATE APPROVED ( )	REMARKS
	a	b	c	d	e	f	g	h
1	.00	Cost through 30 Sept 78				0		Total Study Cost $600,000
	.01	Public Involvement				14		
2	.02	Institutional Studies				2		
	.03	Social Studies				4		
3	.04	Cultural Resources				7		
	.05	Environmental Quality				50		
4	.06	U.S. Fish and Wildlife Service				16		
	.07	Economic Studies				22		
5	.08.	Surveys and Mapping				25		
	.09	Hydrology and Hydraulics				88		
6	.10	Foundations and Materials				5		
	.11	Design and Cost Estimate				10		
7	.12	Real Estate				6		
	.13	Study Management				28		
8	.14	Plan Formulation				16		
	.15	Report Preparation				92		
9	.20	Other Studies Water Quality				10		
10		Recreation				10		
		LMVD				10		
11	.31	Supervision and Administration				65		
12		Subtotal				480		~~NOTE: Study costs~~ are included in ~~the latest PB for~~ the parent study, ~~however, they were~~ not broken out by ~~individual item.~~
		Contingencies				120		
13		Total				600		
14								

DATE PREPARED: 30 Sep 84
DIVISION: Lower Mississippi Valley
DISTRICT: New Orleans
REGION: Lower Mississippi
BASIN: Coastal Louisiana
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PLATE 3

ENG FORM 2204-R, May 82 REPLACES ENG FORM 2204, APR 77 WHICH IS OBSOLETE.

* U.S. Government Printing Office : 1982 - 522-097/364

RCS: DAEN-CWB-12

STUDY COST ESTIMATE (PB-6)
($000)
For use of this form, see ER 11-2-220

APPROPRIATION TITLE: General Investigations
CATEGORY: Surveys
CLASS: Flood Damage Preventions

NAME OF STUDY: Louisiana Coastal Area, LA
Interim Report on Cameron, St.Mary
Iberia, and Vermilion Parishes
SUBCLASS:

LINE NO.	SUBACCOUNT NUMBER	SUBACCOUNT TITLE	CURRENT COST ESTIMATE: RECONNOISSANCE PHASE	CURRENT COST ESTIMATE: FEDERAL FEASIBILITY PHASE	CURRENT COST ESTIMATE: NON-FEDERAL FEASIBILITY PHASE	CURRENT COST ESTIMATE: TOTAL FEASIBILITY PHASE	PREVIOUS FEDERAL COST ESTIMATE AND DATE APPROVED (,)	REMARKS
	a	b	c	d	e	f	g	h
1	.00	Cost through 30 Sept 78				0		Total Study Cost
	.01	Public Involvement				14		$720,000
2	.02	Institutional Studies				2		
	.03	Social Studies				4		
3	.04	Cultural Resources				7		
	.05	Environmental Quality				50		
4	.06	U.S. Fish and Wildlife Service				16		
	.07	Economic Studies				22		
5	.08	Surveys and Mapping				16		
	.09	Hydrology and Hydraulics				70		
6	.10	Foundations and Materials				100		
	.11	Design and Cost Estimates				11		
7	.12	Real Estate				6		
	.13	Study Management				28		
8	.14	Plan Formulation				16		
	.15	Report Preparation				92		
9	.20	Other Studies Water Quality				20		
10		Recreation LMVD				10 10		
11	.31	Supervision and Administration				86		NOTE: Study Costs are included in
12		Subtotal				580		the latest PB for for the parent
13		Contingencies Total				140 720		study, however, they were not
14								broken out by individual item.

DATE PREPARED: 30 Sep 84
DIVISION: Lower Mississippi Valley
DISTRICT: New Orleans
REGION: Lower Mississippi
BASIN: Coastal Louisiana
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PLATE 4

ENG FORM 2204-R, May 82
REPLACES ENG FORM 2204, APR 77 WHICH IS OBSOLETE.

* U.S. Government Printing Office : 1982 - 522-097/364

LOUISIANA COASTAL AREA, LOUISIANA

INITIAL EVALUATION REPORT

ON

LAND LOSS AND MARSH CREATION

APPENDIX A

PLANNING AID REPORT
FISH AND WILDLIFE SERVICE
U.S. DEPARTMENT OF INTERIOR

United States Department of the Interior

FISH AND WILDLIFE SERVICE

POST OFFICE BOX 4305
103 EAST CYPRESS STREET
LAFAYETTE, LOUISIANA 70502

June 18, 1984

Colonel Robert C. Lee
Commander and District Engineer
U.S. Army Engineer District, New Orleans
P.O. Box 60267
New Orleans, Louisiana 70160

Dear Colonel Lee:

Reference is made to the Louisiana Coastal Area Study--Interim Report on Land Loss and Marsh Creation. The Fish and Wildlife Service has prepared the attached planning-aid report to assist your staff in the preparation of an Initial Evaluation Report for this study. Items discussed in the attached report are based on the Scope of Work for the project received from your agency on October 1, 1983. This report does not fulfill our total responsibilities under provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

We will continue to work closely with your staff in an effort to develop feasible, ecologically sound measures to reduce wetland loss in coastal Louisiana. Please keep Dr. Thomas Michot of this office advised as the planning of this study progresses.

Your cooperation in this matter is greatly appreciated.

Sincerely yours,

David W. Fruge

David W. Fruge
Field Supervisor

cc: La. Dept. of Natural Resources (CMS), Baton Rouge, La.
La. Dept. of Wildlife and Fisheries, Baton Rouge, La.
NMFS, Galveston, Tx.
EPA, Dallas, Tx.
FWS, Atlanta, Ga. (AHR)
FWS, Washington, D.C. (ES)

LOUISIANA COASTAL AREA STUDY,

INTERIM REPORT ON LAND LOSS AND MARSH CREATION:

PLANNING AID REPORT

SUBMITTED TO

NEW ORLEANS DISTRICT

U.S. ARMY CORPS OF ENGINEERS

NEW ORLEANS, LOUISIANA

PREPARED BY

THOMAS C. MICHOT, PH. D.

FISH AND WILDLIFE BIOLOGIST

UNDER THE SUPERVISION OF

DAVID W. FRUGE, FIELD SUPERVISOR

U.S. FISH AND WILDLIFE SERVICE

DIVISION OF ECOLOGICAL SERVICES

LAFAYETTE, LOUISIANA

JUNE, 1984

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INTRODUCTION

The New Orleans District, Corps of Engineers (NODCE), is conducting a reconnaissance study of land loss and marsh creation as part of the Louisiana Coastal Area Study (LCAS). The LCAS is being conducted in response to Congressional resolutions adopted in 1967; those resolutions directed the Corps of Engineers to investigate the feasibility of improvements in that area for the purposes of hurricane protection, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and related water resource purposes. The interim report on land loss and marsh creation will identify the causes of land loss and erosion and determine the environmentally and economically feasible solutions that warrant detailed investigation. The study area includes the coastal wetlands in 21 Louisiana parishes that would be inundated by hurricane-induced tidal surges, or roughly lands up to the 5-foot elevation contour.

FISH AND WILDLIFE RESOURCES OF THE STUDY AREA

Habitat Descriptions

Marshes

The marshes in the study area have been classified by Chabreck (1972) as fresh, intermediate, brackish, and saline. These marsh types correspond to palustrine emergent wetlands, estuarine emergent oligohaline wetlands, estuarine emergent mesohaline wetlands, and estuarine emergent polyhaline wetlands, respectively, according to Cowardin et al. (1979). Total marsh acreage in the study area is estimated at 2.5 million acres (based on 1978 aerial photographs interpreted by Wicker et al. (1980) and Wicker et al. (1981); see Table 1). Approximately 72 percecnt of the marshes are located in the eastern half of the study area, known as the Mississippi Deltaic Plain, and 28 percent are in the western portion, or Chenier Plain.

Common vegetation in the fresh marshes of the study area includes bulltongue, sawgrass, maidencane, cattail, smartweed, alligatorweed, spikerush, and deer pea. These marshes are characterized by salinities less than 0.5 parts per thousand (ppt) and are located farthest inland from the Gulf of Mexico. Intermediate marshes are a transitional phase between the fresh and brackish marsh types and have a salinity range of 0.5 to 5.0 ppt. Common species in intermediate marsh include saltmeadow cordgrass, cyperus, bulltongue, southern bulrush, and roseau. There are about 1.2 million acres of fresh and intermediate marsh in the study area (Table 1).

Brackish marsh generally occurs between the intermediate and saline marsh types and is characterized by salinities of 5.0 to 18.0 ppt. Common plants in the brackish marsh include saltmeadow cordgrass, Olney's threesquare, leafy threesquare, saltgrass, saltmarsh cordgrass, big cordgrass, and black rush. There are about 900,000 acres of brackish marsh in the study area (Table 1).

Table 1. Baseline acreage by habitat type for the Louisiana Coastal Area, Deltaic Plain and Chenier Plain regions (data from 1978 aerial photographs, modified by NODCE from Wicker et al. 1980 and Wicker et al. 1981).

Habitat Type	Deltaic Plain	Chenier Plain	Total
Forested wetlands	634,300	3,100	637,400
Emergent marsh			
Fresh/intermediate	725,385	458,128	1,183,513
Brackish	690,303	221,061	911,364
Saline	409,907	24,307	434,214
Total marsh	1,825,595	703,496	2,529,091
Open water	4,913,100	629,300	5,542,400
Total	7,372,995	1,335,896	8,708,891

Saline marshes generally occur adjacent to the Gulf of Mexico and its associated large bays and on barrier islands. Salinities range from 18 to 30 ppt and support plant species such as saltmarsh cordgrass, black rush, saltgrass, saltwort, and glasswort. There are approximately 400,000 acres of saline marsh in the study area.

Wooded Areas

Wooded lands in the study area are of three major types: bottomland hardwoods (seasonally flooded palustrine forested wetlands), wooded swamp (semipermanently flooded palustrine forested wetlands), and palustrine scrub-shrub wetlands. Acreage estimates provided by NODCE were revised from Wicker et al. (1980) and Wicker et al. (1981); those estimates indicate that there are 634,000 acres of forested wetlands in the Deltaic Plain and 3,100 acres of forested wetlands in the Chenier Plain, for a total of 637,400 acres in the study area (Table 1). Other studies have shown acreages that are different from the above figures because of differences in study area bondaries: Bahr et al. (1983) report a total of 537,000 acres of forested wetlands for the Deltaic Plain, and Gosselink et al. (1979) report 16,000 acres of forested wetlands for the Chenier Plain.

The bottomland hardwood habitat type is primarily associated with the relatively higher elevations along natural ridges and floodplains of streams flowing through the study area. This habitat usually floods in winter and spring. Common tree species in bottomland hardwoods include American elm, black willow, water oak, overcup oak, Nuttall oak, swamp chestnut oak, eastern cottonwood, American sycamore, hackberry, red maple, sweetgum, and bitter pecan. There are approximately 114,000 acres of bottomland hardwood habitat in the Deltaic Plain (Bahr et al. 1983).

Wooded swamp habitat occurs at slightly lower elevations than bottomland hardwoods, and hence remains inundated for longer periods of time. Common species include baldcypress, tupelogum, red maple, green ash, buttonbush, water hyacinth, lizard's tail, and duckweed. The Deltaic Plain has approximately 390,000 acres of wooded swamp habitat (Bahr et al. 1983). Scrub-shrub wetlands are dominated by woody vegetation less than 6 m (20 feet) in height, primarily wax myrtle. Other species commonly found in the scrub-shrub areas include spikerush, bulltongue, marsh fern, pennywort, red maple, and alligator weed. There are about 33,000 acres of scrub-shrub habitat in the Deltaic Plain (Bahr et al. 1983).

Open Water Areas

NODCE data (Table 1) show a total of 5.5 million acres of open water in coastal Louisiana. These were classified by Chabreck as ponds and lakes (lacustrine open water; 43 percent), bays and sounds (estuarine open water; 53 percent), bayous and rivers (riverine open water; three percent) and canals and ditches (excavated riverine open water; one percent). A small

percentage of these open water areas are vegetated with submersed and/or floating aquatics such as coontail, widgeongrass, pondweed, watermilfoil, southern naiad, fanwort, white waterlily, duckweed, American lotus, and water hyacinth.

Uplands

Louisiana's coastal region also includes approximately 1 million acres of active beaches, cheniers, spoil deposits, ridges, salt domes, and elevated bayou and lake banks (Chabreck 1972). These areas are vegetated with various species, including live oak, native pecan, sycamore, sweetgum, water oak, baccharis, and black willow.

Fishery Resources

The sport and commercial fishery resources of the Louisiana coastal area are of great economic and recreational importance, and are primarily estuarine and marine in nature. Freshwater sportfishing is generally limited to the upper reaches of coastal rivers and to freshwater lakes and ponds. Primary game species harvested in freshwater include largemouth bass, yellow bass, black crappie, white crappie, bluegill, spotted sunfish, redear sunfish, warmouth, channel catfish, flathead catfish, and blue catfish. Important freshwater commercial fishes include blue catfish, channel catfish, flathead catfish, yellow bullhead, bowfin, carp, gars, and buffaloes.

The Louisiana coastal region provides prime habitat to a variety of estuarine finfishes and shellfishes because of the large quantity of tidal marshes, submersed aquatic beds, and shallow estuarine waters present in the study area. Some of the species are permanent residents of the coastal marshes, while others are only present during their early life stages. The latter species utilize the highly productive low to moderate salinity portions of the study area as nursery areas and move to more saline waters as they mature. Some of the more common estuarine/marine species are listed in Table 2; many of those species are valuable from both the recreational and commercial standpoints.

Louisiana leads the nation in commercial fishery harvest tonnage virtually every year; in harvest value, Louisiana was third (behind Alaska and Massachusetts) in 1983. That year, Louisiana commercial fishermen harvested 1.8 billion pounds valued at $230 million (ex-vessel prices; National Marine Fisheries Service (NMFS) 1984). Gulf menhaden ranked first in tonnage harvested in Louisiana in 1981 with 1.1 billion pounds (89 percent of the total catch), and second in value. Shrimp (brown, white, and pink) ranked first in value and second in tonnage. Oyster meats ranked third in value and fourth in tonnage, while hard-shelled crabs ranked third in tonnage and fourth in value (Becker 1983).

Recreational fishing in the study area is also of substantial economic value. The Louisiana Department of Wildlife and Fisheries (LDWF) estimated

Table 2. A list of common estuarine and marine fishes and shellfishes of commercial or recreational importance in the study area.

Species	
Bull shark	Sheepshead
Blacktip shark	Silver perch
Tiger shark	Sand seatrout
Lemon shark	Spotted seatrout
Atlantic sharpnose shark	Spot
Scalloped hammerhead	Southern kingfish
Tarpon	Gulf kingfish
Gulf menhaden	Atlantic croaker
Atlantic thread herring	Black drum
Blue catfish	Red drum
Gafftopsail catfish	Atlantic spadefish
Sea catfish	Striped mullet
Gulf killifish	Great barracuda
Rock hind; calico grouper	Little tuna; bonito
Bluefish	King mackerel
Cobia	Spanish mackerel
Blue runner	Southern flounder
Crevalle jack	American oyster
Greater amberjack	Rangia clam
Florida pompano	White shrimp
Dolphin	Brown shrimp
Red snapper	Pink shrimp
Gray snapper	Seabob
Vermilion snapper	Blue crab
Tripletail	

the value of marine and freshwater recreational fishing in Louisiana in 1978 at $467 million; commercial fishery retail sales for the same year were valued at $384 million (Becker 1983). Gosselink et al. (1979) estimated the potential sportfishing demand in the Louisiana coastal region to be 10.8 million man-days per year. Louisiana sport fishermen made an estimated 3 million saltwater fishing trips in 1979 (NMFS 1980).

Recent studies have shown that estuarine-dependent fisheries production is closely linked with the total marsh acreage in the associated estuarine drainage area. The marshes serve as the primary source of organic detritus which supports the estuarine food chain. The marshes and associated shallow waters are also extremely important as nursery areas for many estuarine species of finfish and shellfish. Based on an extensive review of available information, we believe that total estuarine-dependent commercial fisheries production in Louisiana has peaked and will decline in proportion to the acreage of marshland loss.

Wildlife Resources

The recreational and commercial value of wildlife resources in Louisiana is substantial. An estimated 2.9 million man-days per year are spent on hunting and nonconsumptive wildlife-oriented recreation in the Louisiana coastal region (Gosselink et al. 1979). In addition, 4.4 million pelts valued at $18 million were taken by Louisiana fur trappers in 1980-81, and 16,300 alligators worth $1.7 million were harvested in the state in 1979 (LDWF data). The vast majority of the fur and alligator harvest in the state is from the coastal marshes. The high productivity of the coastal wetlands serves as the basis for its rich and diverse terrestrial fauna.

Birds

More than 400 species of birds are known to occur in Louisiana, most of them occurring in the coastal region. The coastal marshes are of primary importance to migratory waterfowl; approximately 4 million ducks and 400,000 geese winter there (U.S. Fish and Wildlife Service (USFWS) 1982). About 90 percent of the geese that winter in Louisiana are lesser snow geese (both blue and white color phases) and 9.8 percent are white-fronted geese. One to five thousand Canada geese also winter in these wetlands.

Approximately 92 percent of Louisiana's wintering duck population consists of dabblers, the major species being gadwall, green-winged teal, blue-winged teal, northern shoveler, mottled duck, northern pintail, American wigeon, and mallard. Louisiana's gadwall population represents about 80 percent of the continental population for that species (USFWS 1982). Diving ducks comprise approximately eight percent of Louisiana's duck population. Lesser scaup is the predominant diving duck in coastal Louisiana; about 255,000 (81 percent of the divers) winter in the coastal marshes and another 500,000 to 1 million winter off the Louisiana coast.

Other important divers include ring-necked duck, canvasback, redhead, and ruddy duck (USFWS 1982).

The Louisiana coastal region serves waterfowl not only as a wintering area; it also supports many spring and fall transients en route to their northern breeding grounds and their Central and South American wintering grounds. In addition, three species of ducks nest and rear their broods in coastal Louisiana. Five to eight thousand fulvous whistling ducks are summer residents of Louisiana. This species nests outside of the study area in the rice fields of southwest Louisiana, but it uses the coastal marshes as staging areas during fall migration to Mexico and on returning from there in the spring (Bellrose 1976). Louisiana has a breeding population of about 30,000 wood ducks, many of which nest in the forested wetlands of the study area. The coastal marshes also suppoort a breeding population of about 50,000 mottled ducks, which represents about half of the continental population (Bellrose 1976). Many more individuals of the latter two species also winter in Louisiana.

Some of the major waterfowl concentration areas in the Louisiana coastal area are shown in Figure 1. High concentrations also occur on the Federal and State wildlife areas in the coastal region. The marshes of the study area support more than two-thirds of the Mississippi Flyway waterfowl population (Bellrose 1976). During the 1979-80 season, more than 500,000 man-days were spent on waterfowl hunting in coastal Louisiana and 1.5 million ducks were bagged (LDWF 1980).

The study area provides important habitat for numerous other resident and migratory birds. Important game species include American coot, clapper rail, king rail, sora, common moorhen, purple gallinule, American woodcock, and common snipe. Hunting of these species in coastal Louisiana accounts for 38,000 man-days per year of recreation (Gosselink et al. 1979).

Hundreds of nongame species of birds inhabit the study area. Twenty-eight species of seabirds and wading birds are known to have established nesting colonies in the study area (Portnoy 1977; Keller et al. 1984); these species are listed in Table 3. In 1983 there were 188 active bird colonies in coastal Louisiana (Keller et al. 1984); the locations of the colonies are shown in Figure 2. Other common waterbirds which are not colonial nesters in Louisiana include the least bittern, wood stork, American white pelican, pied-billed grebe, magnificent frigatebird, black-necked stilt, American avocet, killdeer, black-bellied plover, willet, and various sandpipers, gulls, and terns (Lowery 1974a).

The coastal wetlands support many species of resident and transient hawks and owls. Permanent residents include red-shouldered hawk, black vulture, turkey vulture, barn owl, common screech owl, great horned owl, and barred owl. The red-tailed hawk, marsh hawk, and American kestral are winter residents and the Mississippi kite and broad-winged hawk are common summer residents (Lowery 1974a).

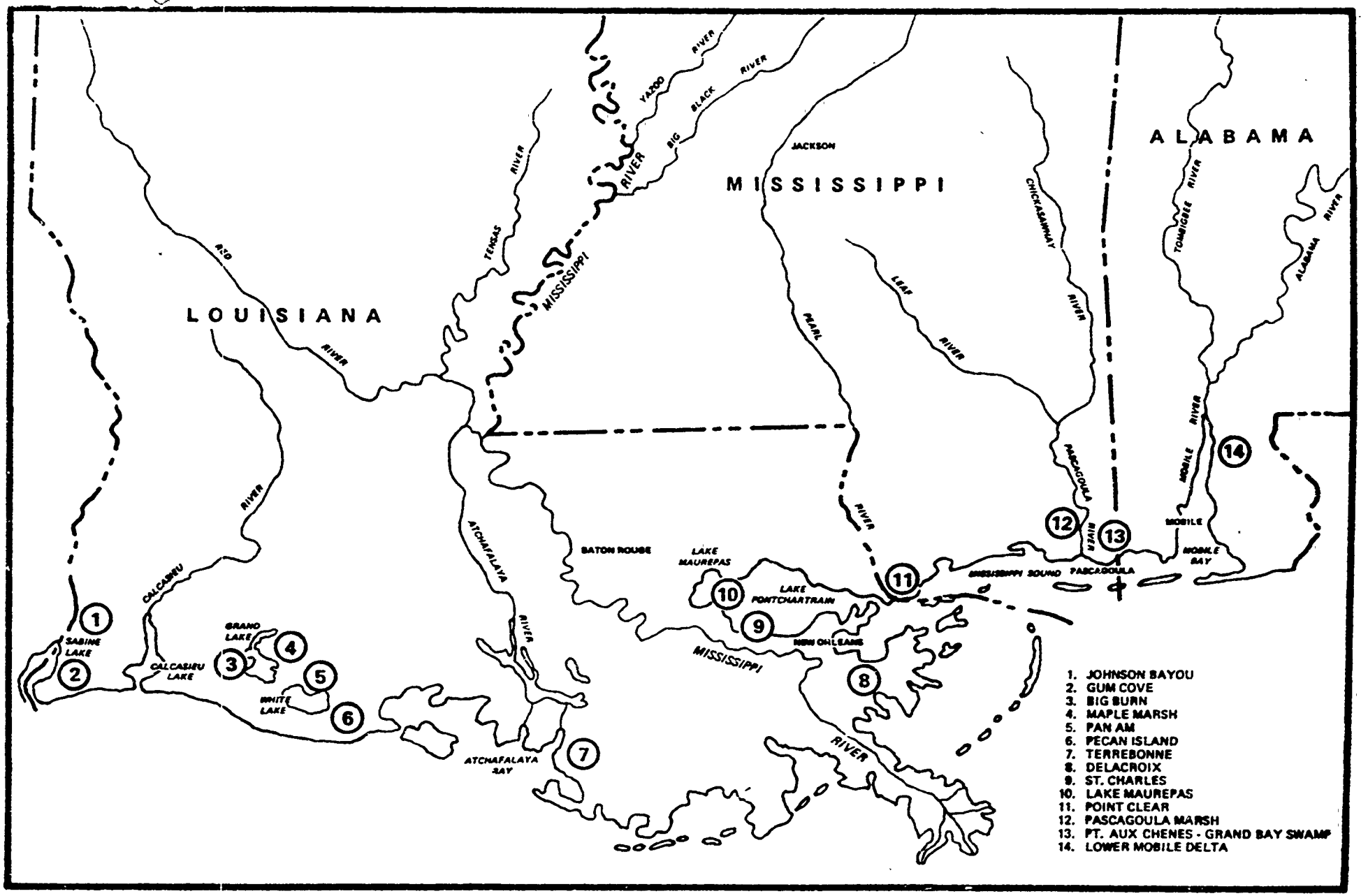


Figure 1. Key waterfowl wintering areas along the Central Gulf Coast, as identified by USFWS (1982).

Table 3. Species of birds for which colonies were censused in coastal Louisiana by Portnoy (1977) and/or Keller et al. (1984).

Species	
Brown pelican	Glossy ibis
Olivaceous cormorant	White ibis
Anhinga	Roseate spoonbill
Great blue heron	Laughing gull
Great egret	Gull-billed tern
Snowy egret	Forster's tern
Reddish egret	Common tern
Cattle egret	Sooty tern
Tricolored heron	Least tern
Little blue heron	Sandwich tern
Black-crowned night heron	Caspian tern
Yellow-crowned night heron	Royal tern
Green-backed heron	Black skimmer
White-faced ibis	American oystercatcher

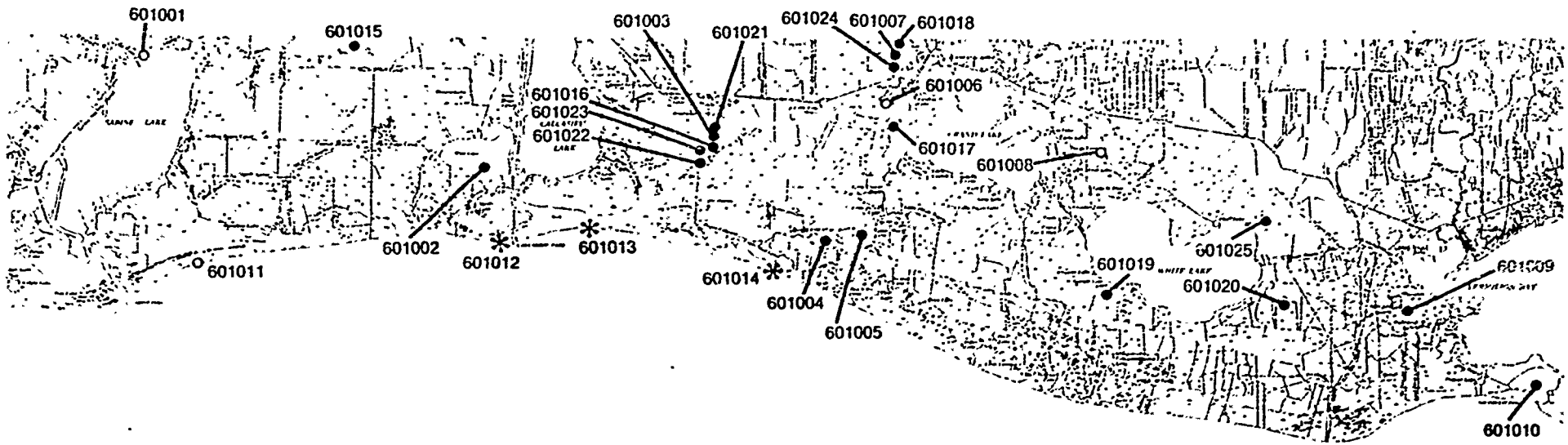
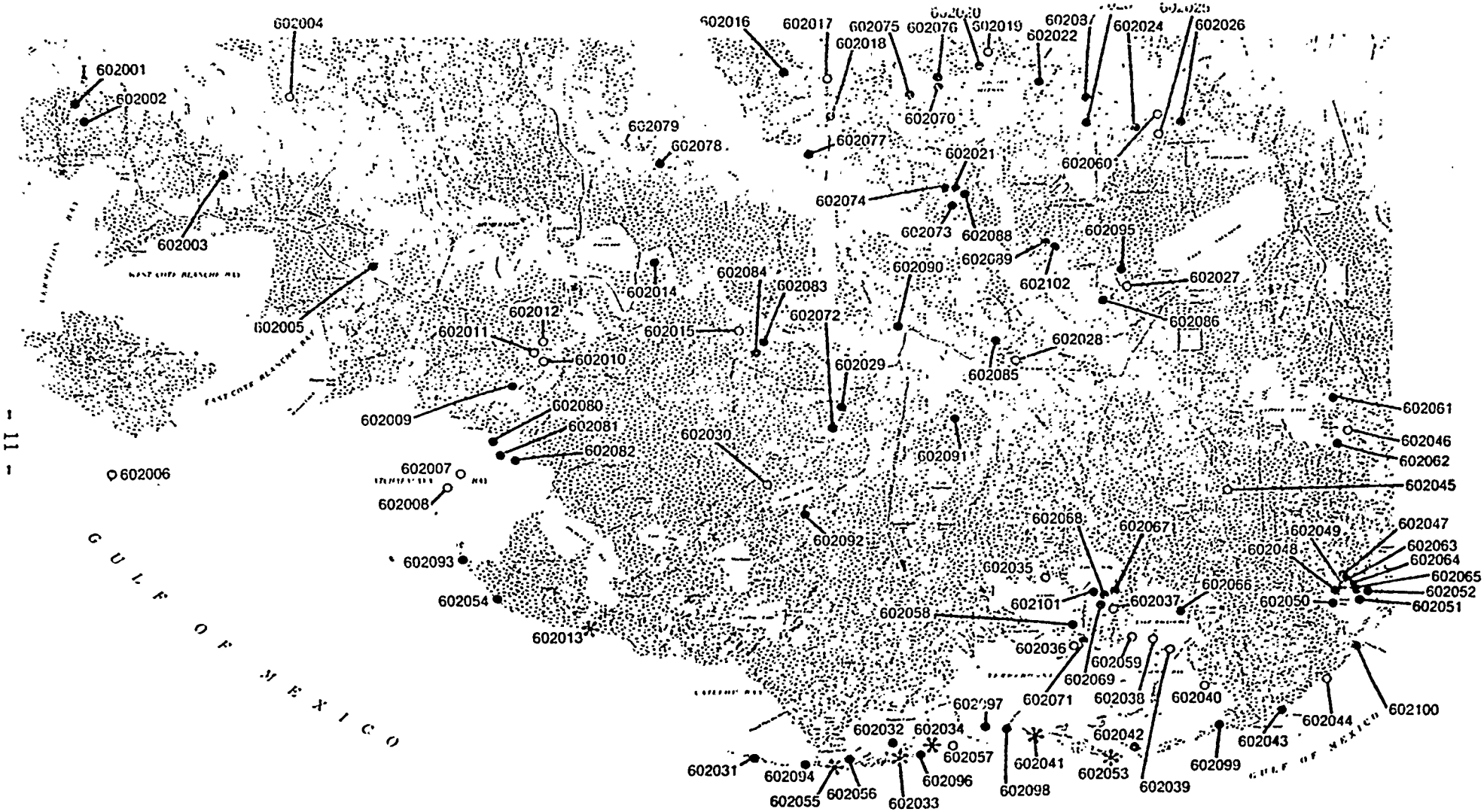


Figure 2. Locations of bird colonies, in the Louisiana coastal area, censused by Keller et al. (1984); ● = colonies active in 1983; c = colonies active historically (Portnoy 1977) but inactive in 1983; * = historic least tern colonies (could not be verified in 1983); reference numbers are from Keller et al. (1984).



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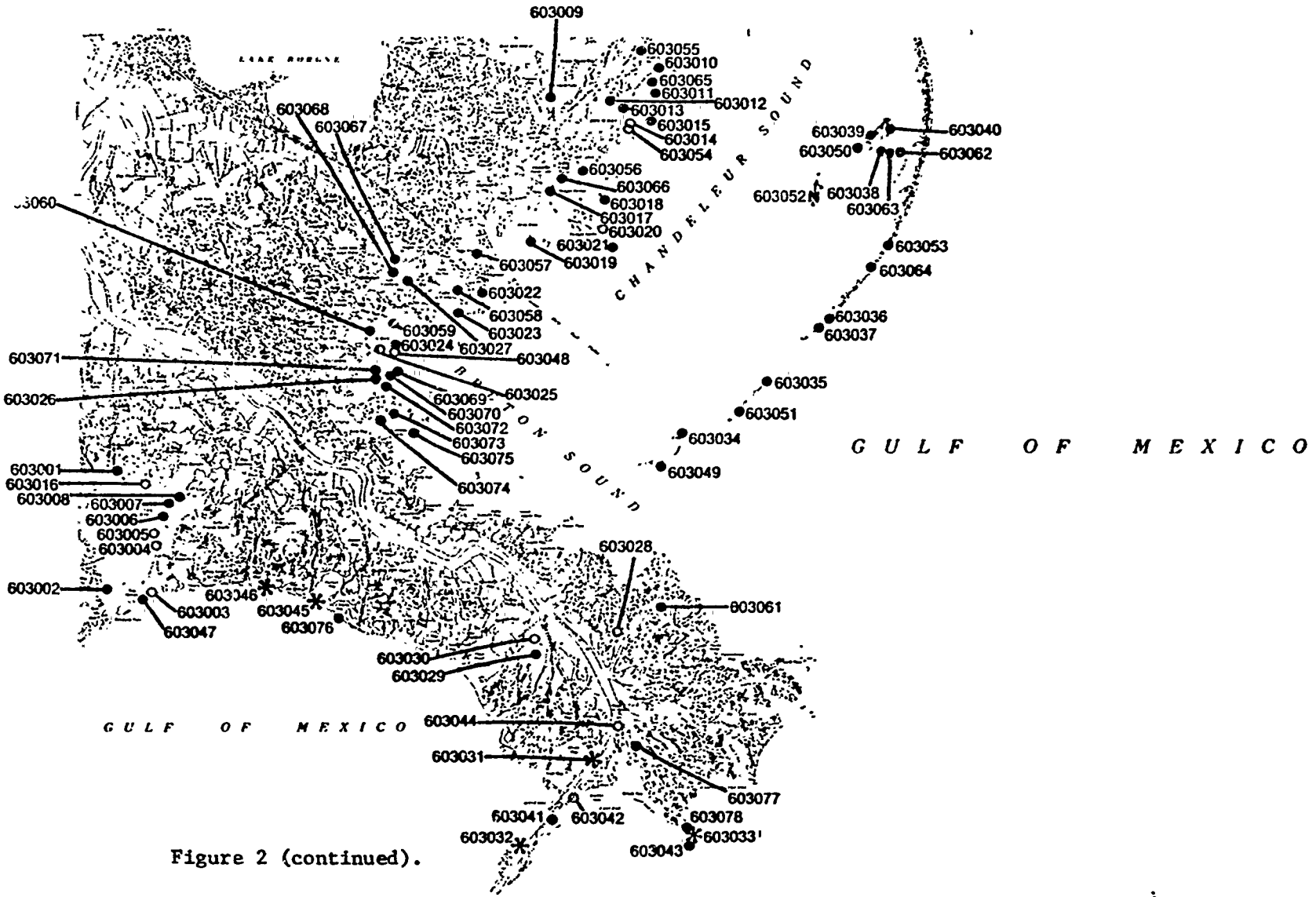

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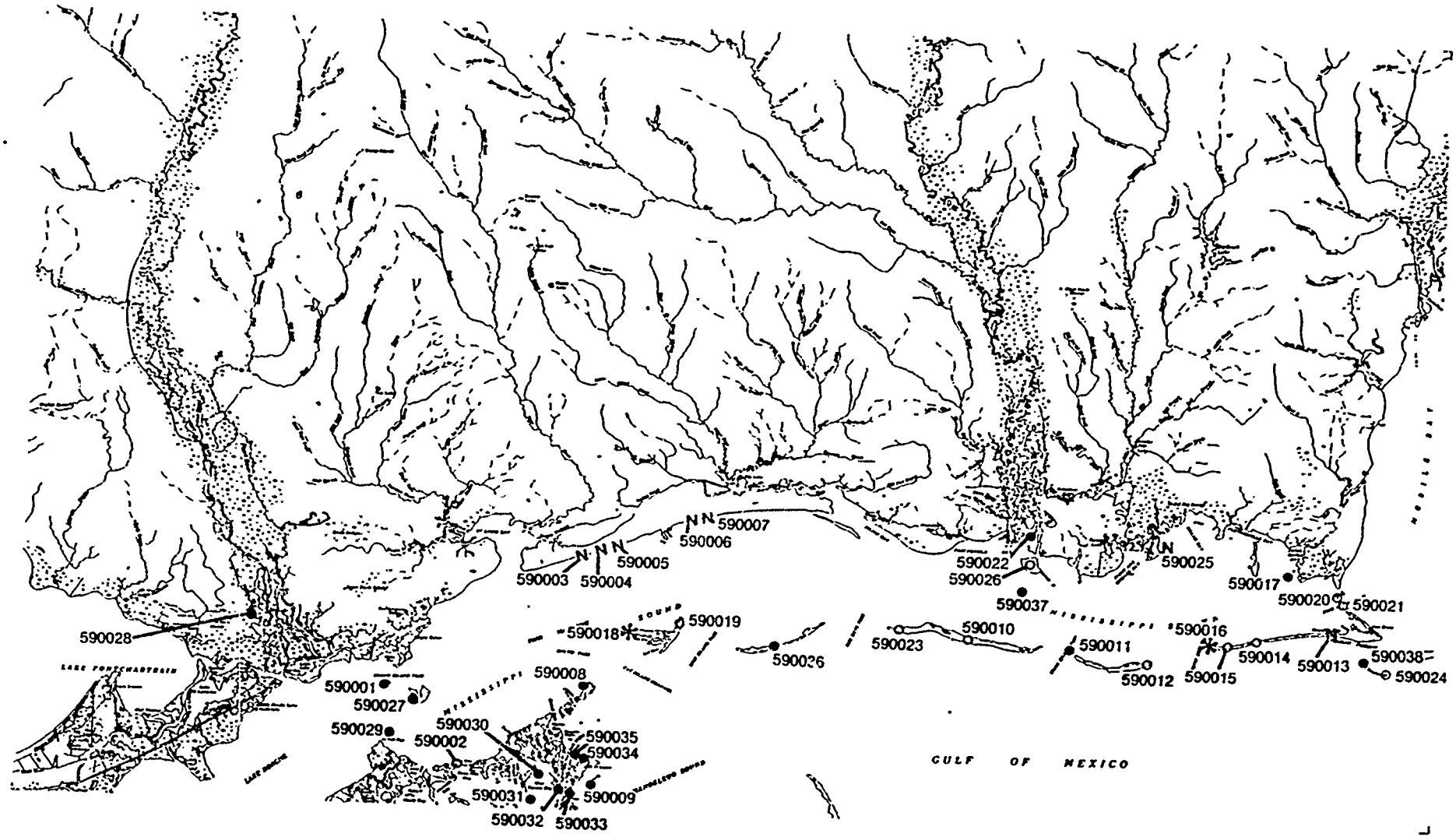

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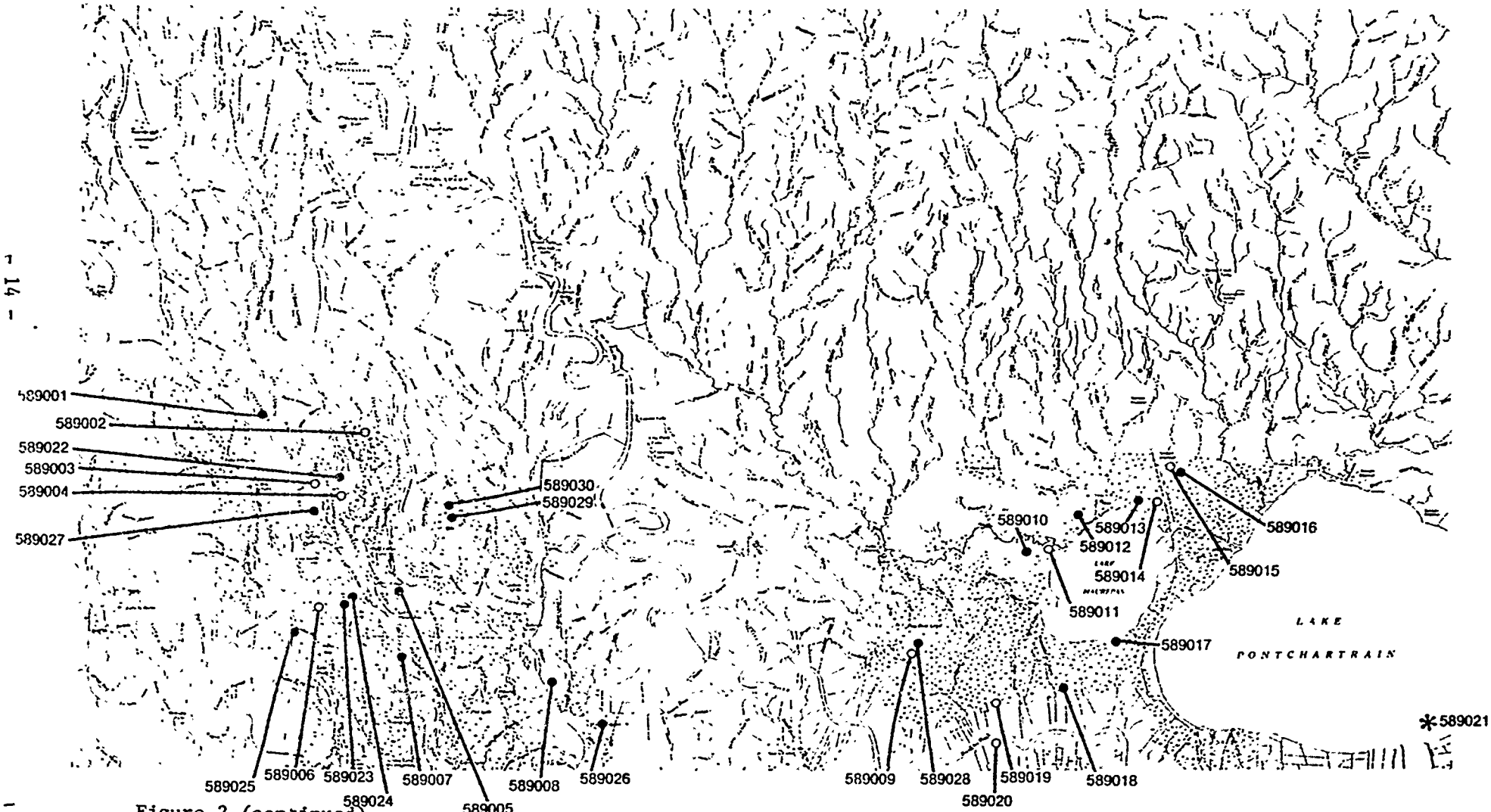

Figure 2 (continued).

The Louisiana coastal area supports many species of passerines and other small birds. Trans-Gulf migrants from Central and South America fly due north from the Yucatan peninsula in Mexico to the Louisiana coast in the spring. The state's coastal wetlands and associated forested ridges serve as valuable stopover points after the nonstop flights across the Gulf. Likewise, the area serves as an important staging area for these species in the fall. This is true for transient species enroute to and from their breeding grounds to the north, as well as for species which nest in coastal Louisiana and winter farther south. Included are about 180 species of passerines and a few species of cuckoos, swifts, hummingbirds and goatsuckers. The belted kingfisher and several species of woodpeckers are residents of the study area as well (Lowery 1974a).

Mammals

Louisiana has 58 species of land mammals (Lowery 1974b); many of those reside in the coastal marshes and are of economic importance as game or furbearers. Important game mammals in the study area include white-tailed deer, eastern cottontail, swamp rabbit, gray squirrel, fox squirrel, and raccoon. Important furbearers are muskrat, nutria, raccoon, mink, opossum, skunk, bobcat, beaver, and coyote. Other land mammals found on the study area include various species of insectivores, bats, and rodents, and the nine-banded armadillo. Numerous species of whales and dolphins inhabit the Gulf waters adjacent to the study area; some occasionally enter estuarine areas.

The white-tailed deer, the primary big game mammal in the study area, is chiefly associated with palustrine forested wetlands; significant populations also occur in fresh to brackish marshes, especially when higher ground is located nearby. The LDWF has estimated that, in Louisiana's coastal region, deer hunters spent 346,600 man-days and harvested 13,100 deer during the 1980-81 season.

The eastern cottontail is most frequently found on higher ground (levees, agricultural lands, etc.) adjacent to the wetlands of the study area, whereas the swamp rabbit usually inhabits the forested wetlands and fresh to brackish marshes. LDWF estimated that 298,000 man-days were spent on rabbit hunting in the coastal parishes in 1977-78, with 544,000 rabbits being harvested.

Both the gray and fox squirrels occur in the forested wetlands of the study area. Approximately 196,000 man-days of squirrel hunting in the coastal parishes resulted in a harvest of 343,000 squirrels in 1977-78 (LDWF data).

The northern raccoon is a game animal as well as a commercially important furbearer. The animals are hunted at night, with or without dogs, usually in forested areas. The raccoon that inhabits the coastal marshes is a different subspecies from the one in the rest of the state (Lowery 1974b). In 1981-82, 73,000 raccoons were trapped in coastal Louisiana for a value

of $524,000 (LDWF records). This species ranks third in numbers harvested, behind nutria and muskrat, although its value may exceed that of the muskrat (as it did in 1981-82).

The muskrat was the most important furbearer in the state until 1961-62, when the take of that species was surpassed by that of the nutria; the nutria has retained this status through the present. Both species are common in forested wetlands but reach their highest densities in the marshes. The nutria reaches highest densities in fresh marshes and the muskrat in brackish, although both species have been known to reach substantial densities in other marsh types and they often occur together. In the 1981-82 trapping season the nutria harvest was 961,000 pelts, worth $4.2 million while the muskrat take was 387,000 pelts, worth $1.0 million. Annual harvest of these two species fluctuates depending on market prices as well as population densities, the latter being largely a function of habitat quantity and quality. The highest catch for either species during the period of record (1913 to present) was 8.3 million muskrat pelts harvested in 1945-46 (Lowery 1974b).

The North American mink and nearctic river otter are abundant in the forested and marsh habitats of the study area. In the 1981-82 trapping season, 32,000 mink and 6,000 otter were harvested in the state, for values of $385,000 and $130,000, respectively. Approximately 80 percent of the state's otter harvest is from the coastal area (O'Neil and Linscombe 1976). The Virginia opossum, coyote, striped skunk, and bobcat are primarily associated with the bottomland hardwood and wooded swamp habitats in the study area.

Amphibians and Reptiles

Amphibians are generally restricted to the freshwater marshes, ponds, stream and lake margins, and forested wetlands of the study area. The bullfrog and pig frog are important from a commercial and recreational standpoint. Other representative amphibians include lesser siren, three-toed amphiuma, Gulf Coast toad, Fowler's toad, green treefrog, spring peeper, cricket frog, eastern narrow-mouthed toad, and bronze frog.

Commercially important reptiles occurring in the marshes and swamps include the American alligator, common snapping turtle, alligator snapping turtle, smooth softshell turtle, spiny softshell turtle, and diamondback terrapin. In 1979, 16,300 alligators were harvested in Louisiana (predominantly from the coastal region) for a value of $1.7 million.

Other reptiles common in the palustrine habitats include red-eared turtle, painted turtle, stinkpot, Mississippi mud turtle, green anole, broad-headed skink, diamondback water snake, broad-banded water snake, green water snake, Gulf salt marsh snake, western ribbon snake, speckled kingsnake, and western cottonmouth. The Gulf salt marsh snake and diamondback terrapin are common in the brackish to saline marshes as well.

Endangered and Threatened Species

Several endangered species are found in the study area. Endangered birds known to occur in the area include the American bald eagle and brown pelican; the threatened arctic peregrine falcon is also a seasonal visitor to the area. Approximately fourteen bald eagle nesting territories are known to be located in the study area; the coastal forests and marshes serve as feeding areas for the breeding birds as well as occasional wintering eagles. Approximately 500 resident brown pelican nests are located on Queen Bess Island in the lower Barataria Basin and on the North Islands in Chandeleur Sound; the pelicans feed in estuarine waters adjacent to these islands.

Other endangered birds that may occur in the study area include the ivory-billed woodpecker, Bachman's warbler, and the Eskimo curlew. Endangered land mammals that may occur on the area include the Florida panther and the red wolf. There have been reported sightings for some of these species in recent years, but none have been confirmed. Endangered marine vertebrates which may venture into the nearshore waters and/or beaches of the study area include the blue, finback, humpback, sei, and sperm whales and the hawksbill, Kemp's ridley, and leatherback sea turtles; the threatened green and loggerhead sea turtles may be found in the study area as well.

Species of Special Emphasis

The study area supports 18 species considered by the FWS to be National Species of Special Emphasis (Federal Register, Vol. 48, No. 237, December 8, 1983). These species are coyote, brown pelican, white-fronted goose, snow goose, Canada goose, wood duck, black duck, mallard, pintail, canvasback, ring-necked duck, osprey, bald eagle, peregrine falcon, American woodcock, eastern least tern, mourning dove, and American alligator. Also present in the study area are 35 species highlighted by the Regional Resource Plan for the Southeast Region; these include coyote, brown pelican, white-fronted goose, Canada goose, snow goose, wood duck, mallard, black duck, mottled duck, redhead, canvasback, ring-necked duck, osprey, bald eagle, peregrine falcon, clapper rail, wood stork, American woodcock, least tern, mourning dove, red-headed woodpecker, pileated woodpecker, starling, common grackle, brown-headed cowbird, red-winged blackbird, eastern bluebird, seaside sparrow, American alligator, loggerhead turtle, green turtle, leatherback turtle, hawksbill turtle, striped bass, and Atlantic sturgeon.

Public Wildlife Areas

National Wildlife Refuges (NWR's) in the study area include Breton NWR (including Breton National Wilderness Area), Delta NWR, Shell Keys NWR, Lacassine NWR, and Sabine NWR. The study area also includes Jean Lafitte National Historical Park.

State Wildlife Management Areas (WMA's) in the study area include Biloxi, Bohemia, Manchac, Salvador, Pass a Loutre, Wisner, Atchafalaya Delta, Pearl River, Joyce, and Pointe au Chien WMA's. In addition, the state manages St. Tammany Wildlife Refuge, Marsh Island Wildlife Refuge and Game Preserve (WRGP), Louisiana State WRGP, and Rockefeller WRGP.

HABITAT-RELATED PROBLEMS AND OPPORTUNITIES

This study deals primarily with coastal land loss as a problem and marsh creation as an associated opportunity. It is estimated that the conversion of wetlands (primarily marsh) to open water is occurring in coastal Louisiana at a rate of 50 square miles per year (Gagliano 1984; Figure 3). Wetland loss also includes the conversion of wetlands to uplands (Bahr et al. 1983). An associated problem is the conversion of wetlands from one habitat type to another. Subsidence and/or saltwater intrusion can result in the conversion of wooded swamp to marsh and the conversion of the fresher marshes to a more saline habitat type.

Land loss and habitat conversions and their projected geometric increase in future years have serious biological as well as socioeconomic impacts. Aquatic animals, although they will gain available open water habitat, will be adversely affected by the decreases in productivity and detrital export associated with marsh loss, resulting in decreased food supplies. All terrestrial animals will be affected by the loss of nesting and feeding habitat and escape cover.

The marshes of the study area are extremely important to the maintenance of its estuarine-dependent sport and commercial fisheries. These wetlands produce vast amounts of organic detritus, an important trophic component of estuarine fish and shellfish productivity (Odum et al. 1973; Peters and Schaaf 1981). The marshes and associated shallow waters of the study area are also important as nursery habitat for many estuarine-dependent species such as Atlantic croaker, spot, menhaden, sand seatrout, southern flounder, brown and white shrimp, and blue crab. This importance has been documented by numerous authors, such as Herke (1971), White and Boudreaux (1977), Rogers (1979), Simoneaux (1979), More (1969), Conner and Truesdale (1973), and Chambers (1980). There is growing evidence that the amount of marsh is the most important factor influencing estuarine-dependent fishery production. Turner (1979) reported that Louisiana's commercial inshore shrimp catch is directly proportional to the area of intertidal vegetation, and that the area of estuarine water does not seem to be directly associated with shrimp yields. He further noted that the loss of wetlands in Louisiana has a direct negative effect on fisheries. Barrrett and Gillespie (1973) reported a correlation between acres of nursery grounds available during April and May and brown shrimp production. Although the effects are masked by large annual variations in yield, wetland losses reported by Craig et al. (1979) are equivalent to 6.31 million pounds of shrimp harvest "lost" over the past 20 years (Turner 1979). Lindall et al.

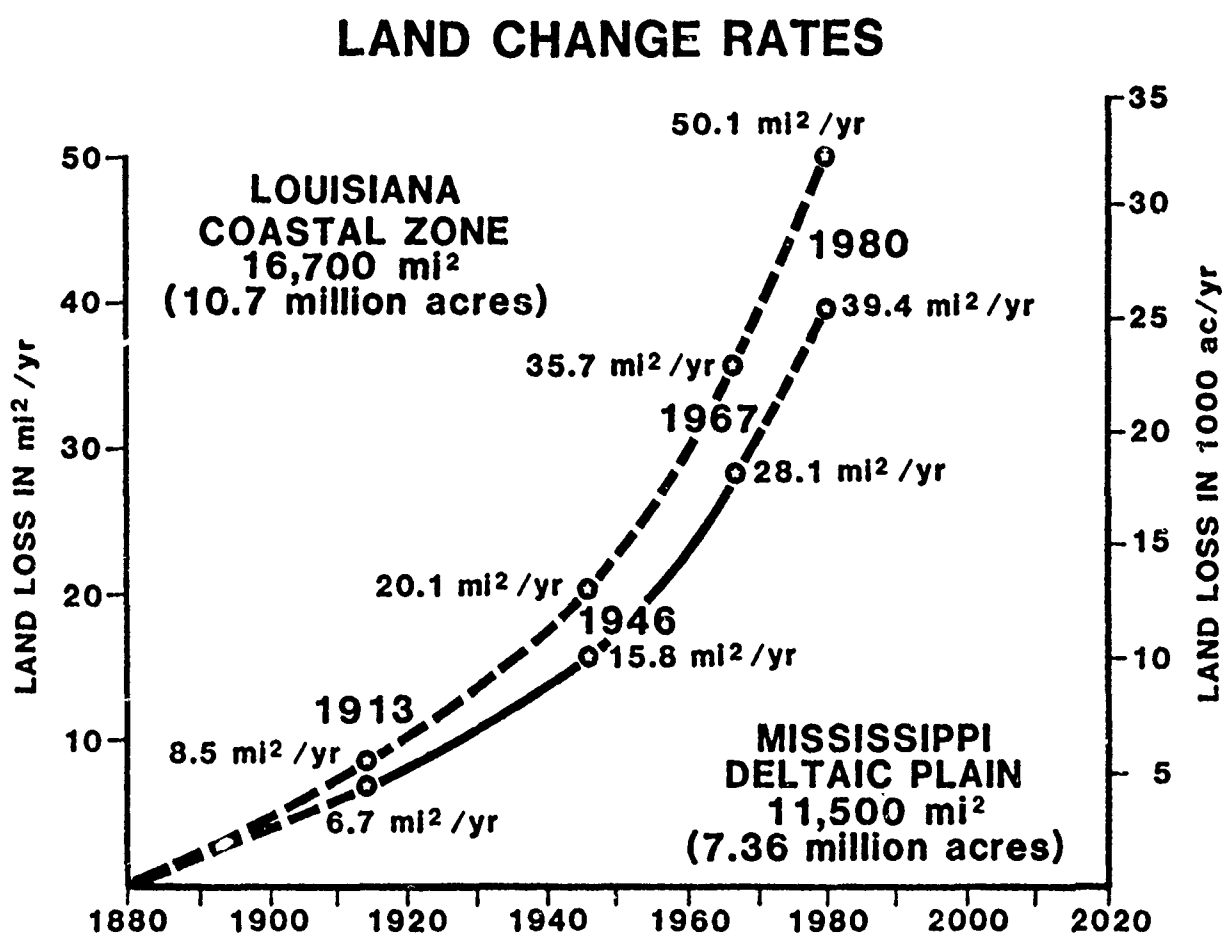

Figure 3. Curves showing rates of land change in the Louisiana coastal zone for the period of 1880 to 1980. The Mississippi deltaic plain is that part of the coastal zone lying between the Vermilion River and the Chandeleur Islands (after Gagliano 1984).

(1972) presented evidence that shrimp and menhaden are being harvested at or near maximum sustainable yield. These species accounted for nearly 99 percent of the total volume of Louisiana's commercial fish and shellfish landings in 1976. An analysis of the dependence of menhaden catch on wetlands in the Louisiana coastal region was conducted by Cavit (1979). The findings of this analysis suggest that menhaden yields are greatest in those estuarine basins having the highest ratio of marsh to open water. Based on the evidence cited above, continued wetland loss in the study area could lead to serious declines in its estuarine-dependent fishery.

Wildlife species dependent on the Louisiana coastal marshes face serious habitat declines as a result of future land loss and saltwater intrusion. Losses of fresh and intermediate marsh types or conversion of these wetlands to more saline types will adversely affect migratory puddle ducks, since relative abundance of these waterfowl in Louisiana's coastal region is highest in the fresher marsh types (Palmisano 1973). Based on rather conservative projections of declines in habitat quality and abundance in the study area, it has been estimated that demand for waterfowl hunting will exceed available supply by 454,000 man-days by the year 2020 (USFWS 1976) . Habitat quality and quantity for other marsh birds such as rails, gallinules, American coot, and various wading birds will also be reduced by continued wetland deterioration.

Nutria comprised roughly 70% of Louisiana's total fur harvest between 1970 and 1975 (O'Neil and Linscombe 1976); nutria catch per acre is highest in fresh marsh, declining progressively in the intermediate, brackish, and saline marsh types (Palmisano 1973). Thus, nutria as well as other species of furbearers are impacted by the loss of marsh habitat and the change from fresh to more saline habitat types. Alligator populations also reach peak levels in fresh to intermediate marshes (McNease and Joanen 1978). Accordingly, continued wetland deterioration can be expected to result in declines in fur harvest and alligator populations, especially as land loss and saltwater intrusion reduce fresher marsh acreage.

Factors Affecting Wetland Loss

Wetland losses result from both natural and man-induced causes. The principal natural processes that contribute to wetland loss are erosion and subsidence (or relative sea level rise). These forces are always present in the marshes, but their net effect depends on the extent that they are counteracted by marsh-building forces (e.g., sediment deposition). In addition, man-induced factors can interact with the natural processes to greatly accelerate wetland deterioration.

There was a gradual net land gain in the Louisiana coastal region from 7,000 years before present (B.P.) to approximately the end of the nineteenth century (Bahr et al. 1983, Gagliano et al. 1981). Since sea level rise stabilized about 4,500 years ago, the Mississippi River has occupied seven major courses, each with a major delta lobe and a number of minor lobes and distributary channels (Frazier 1967). The eighth active

delta lobe of the Mississippi River is presently being formed at the mouth of the Atchafalaya River. At intervals of approximately every 700 to 1000 years the main flow of the river diverted to a shorter, steeper route to the Gulf of Mexico. When this occurred, a new land-building phase in the delta cycle was initiated concurrent with the beginning of the abandonment phase of the delta associated with the former route. These changes result principally from a shift in sediment transport from the developed delta to an open water area. Sedimentation in the open water area results in land formation and river channel elongation until an unfavorable flow gradient occurs; then another shorter route to the Gulf is found and the land building phase is re-established elsewhere. As sediment distribution to the abandoned delta diminishes, the erosional forces gradually play a greater role in the delta as it enters the destructional phase.

Erosion and subsidence are the dominant forces in the interdistributary marshes of previous delta lobes. Wave attack from the Gulf of Mexico to the coastal shoreline and from inland streams and lakes to their adjacent marshes results in land loss via shoreline erosion. Without a periodic source of sediment, the effect of subsidence in inland marshes is magnified. The subsidence factor is compounded by the apparent rise in sea level; it is often difficult to distinguish between sinking land and rising water. However, recent studies have indicated that the rate of global sea level rise (estimated at 1.5 mm/yr) is much lower than the rate for coastal Louisiana (10 to 40 mm/yr); this implies that subsidence is the dominant process in the latter area (Boesch et al. 1983).

The lack of periodic riverine flooding in an abandoned delta lobe has two additional ramifications. The high rate of nutrient input associated with overbank flooding is lost to the marshes, resulting in decreased plant vigor and increased susceptibility to other land loss factors (e.g., erosion, subsidence, saltwater intrusion). In addition, the lack of fresh water input into the basin allows saline waters from the Gulf to encroach farther inland. Brackish waters kill the fresh marsh plants and, before plants that are more salt-tolerant can become established, the organic substrate often disappears due to erosion, subsidence, and oxidation. The result is establishment of open water where there was previously fresh marsh.

Natural causes of land loss have been augmented by man's activities in recent times. The cyclic delta-building process has been thwarted by the leveeing of the Mississippi River, which prevents overbank flooding; by the operation of the Old River Control Structure, which prevents rediversion of the main flow to the Atchafalaya; and by the maintenance of Southwest Pass as a navigation channel, which results in the major sediment load of the Mississippi being dumped into deep Gulf waters.

Canalization in the coastal wetlands has contributed significantly to land loss. Estimates of the proportion of land loss that can be attributed to canals range from 20 percent (Johnson and Gosselink 1982) to 90 percent (Turner et al. 1982). Canals are dredged primarily for navigation, oil and

gas drilling, and pipelines. Many factors contribute to the damage caused by canals. The direct impact deals with physical removal of the emergent marsh by the channel excavation and burial of adjacent marsh by the spoil disposal. Indirect impacts result from hydrologic alterations. Long canals often cut through two or more marsh types and thus serve as an avenue for salt water intrusion into the fresher types. Since canals are usually deeper and straighter than natural streams, they often capture the flow of those streams. Overbank flooding then decreases in frequency and duration because of the increased hydrologic efficiency of canals. By the same token, mean marsh water levels often decrease due to increased drainage into the canals. This may lead to oxidation and increased subsidence. The spoil banks from two or more canals often disrupt sheet flow and cause impoundment of waters on one side and nutrient starvation on the other; both of these factors lead to plant mortality and potential marsh loss.

The increased erosion and altered hydrologic patterns associated with canals causes them to widen over time (Craig et al. 1979, Johnson and Gosselink 1982). The increase in cross sectional area and density of canals results in a decrease in the cross sectional area and density of natural streams, which further alters hydrologic patterns and accelerates marsh loss (Bahr et al. 1983). Recent studies have shown a significant correlation between canal density and wetland loss (Scaife et al. 1983, Turner et al. 1982, Deegan et al. 1982, Cleveland et al. 1982).

Other human activities which contribute to wetland loss include flood control and reclamation projects. There is also evidence that our burning of fossil fuels has increased the amount of carbon dioxide and other "greenhouse" gases in the atmosphere; this is expected to result in a gradual increase in global temperature (Seidel and Keyes 1983). The projected warming for the next century would be ten times as rapid as the historical warming trend (Hoffman et al. 1983). A corresponding increase in the rate of sea level rise is also predicted based on thermal expansion of oceanic waters and transfer of snow and ice from land to sea. Predictions of the extent of sea level rise range from 13.0 cm (5.1 inches) to 54.9 cm (21.6 inches) by the year 2025 and from 56.2 cm (22.1 inches) to 345.0 cm (135.8 inches) by 2100 (Hoffman et al. 1983). The effects that such factors would have on the Louisiana coast would obviously be severe.

Areas of Greatest Land Loss in Coastal Louisiana

There are five general areas in Louisiana's coastal region that are experiencing very severe (i.e., at least 4 acres/mi^2/yr) land loss (Figure 4). These include the St. Bernard area, the Mississippi Delta area, the Terrebonne-Lafourche area, the Chenier Basin, and the Calcasieu Basin.

Greatest land loss in the St. Bernard area is occurring in the brackish to saline marshes along the coast and inland in vicinity of Ysclosky and Lena Lagoon (Figure 4). These marshes are in the lower end of the Pontchartrain

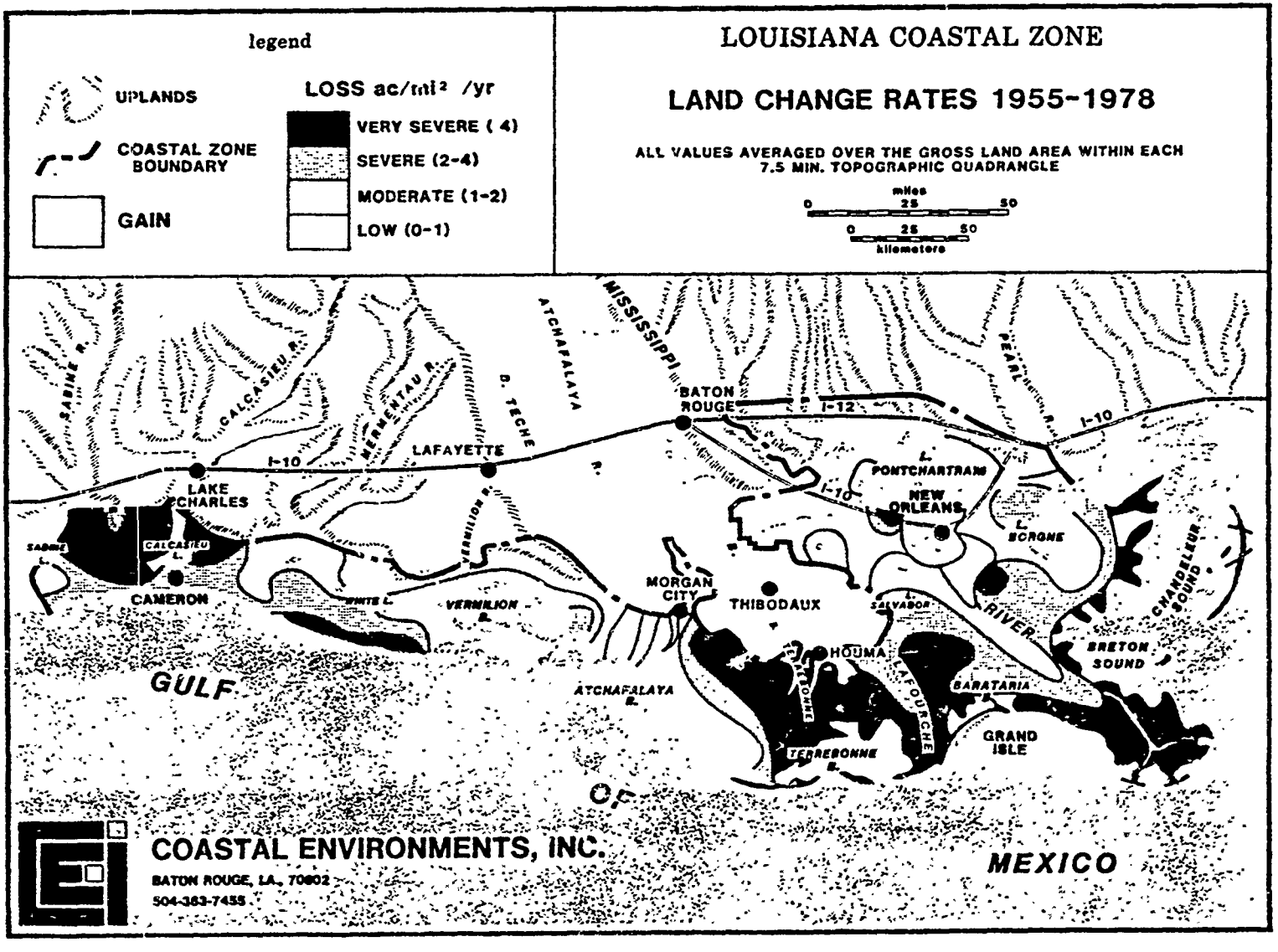

Figure 4. Land change rates in the Louisiana coastal zone as determined from comparative measurements of aerial photographs (after Gagliano 1984).

Basin (Hydrologic Unit II, Bahr et al. 1983) and were originally built by the St. Bernard Delta complex from about 2500 to 1000 years B.P. The major causes of wetland loss there are erosion, subsidence, and salt water intrusion. Rapid deterioration of the Chandeleur Island chain has allowed the coastline to be subjected to increased wave erosion. The lack of freshwater inflow from the Mississippi has resulted in sediment and nutrient starvation and subsequent subsidence and salt water intrusion. The construction of the Mississippi River-Gulf Outlet (MRGO) has contributed significantly to the problems of erosion and saltwater intrusion in addition to its direct impact of marsh destruction. Total marsh loss in Hydrologic Unit II from 1955 to 1978 was 79,255 acres (Bahr et al. 1983).

The most severe land loss in the Mississippi Delta is in the marshes adjacent to the river downstream from Empire, Louisiana (Figure 4); most of these marshes, together with the levees and batture lands along the river below New Orleans, are included in Hydrologic Unit III (Bahr et al. 1983). Significant land loss is also occurring in the wetlands adjacent to the river from Belle Chasse to Empire. The major factor contributing to land loss in these areas is the Mississippi River levee system, which greatly reduces sediment and nutrient inflow into adjacent marshes. The only sites of active delta building are where natural or man-made crevasses in the levees occur. The current apparent subsidence rate in the Mississippi Delta is approximately 40 mm/yr (1.6 inches/yr), the highest known for the entire study area (Boesch et al. 1983). As the size of open water areas increases, the remaining marshes become more susceptible to wave erosion. Also, the modern delta receives the greatest erosional stress because of its close proximity to the Continental Shelf, where wave energy is highest (Bahr et al. 1983). Hydrologic Unit III lost a total of 119,238 acres of marsh between 1955 and 1978 (Bahr et al. 1983).

The Terrebonne-Lafourche marshes are undergoing severe loss between Barataria Bay on the east and the Lake Mechant-Bayou Penchant area on the west (Figure 4). These wetlands are in Hydrologic Units IV and V, the Barataria and Terrebonne Units (Bahr et al. 1983); the two units are separated by Bayou Lafourche. That stream contained the main flow of the Mississippi River about 3500 years B.P., and it remained as an active distributary until 1904 when it was artificially closed off from the Mississippi River. The resulting lack of inflow from the Mississippi to the Terrebonne-Lafourche marshes is one of the main causes for their deterioration. Another significant factor is the extensive canalization in the area. Construction of the Gulf Intracoastal Waterway, the Houma Navigation Canal, the Barataria Bay Waterway, and hundreds of oilfield location and pipeline canals have contributed substantially to the wetland deterioration in this area. Impoundments and attempted marsh reclamation projects have taken their toll as well. Adams et al. (1978) reported that this area was experiencing the highest overall loss of wetlands to open water; they also reported that the Lafourche Parish coastline had the highest rate of retreat in the state (207 meters or 679 feet between 1954

and 1969). Total marsh loss in Hydrologic Units IV and V was 459,945 acres between 1955 and 1978 (Bahr et al. 1983).

The Chenier Basin is located west of Vermilion Bay between the Mermentau Basin and the Gulf of Mexico (Gosselink et al. 1979). This area was originally part of the Mermentau/Chenier drainage system, but Grand Chenier, Little Pecan Island, Pecan Island, and other chenier ridges and a number of water control structures (in operation since 1950) have hydrologically separated the two basins. The two basins are considered as a single Hydrologic Unit by some authors (e.g., Chabreck 1972, Adams et al. 1978, Wicker 1981). Fresh water enters the Chenier Basin from the Mermentau Basin through the Catfish Point control structure, which is located on the Mermentau River near the southwest corner of Grand Lake. The Mermentau River below that point is thus included in the Chenier Basin.

The Chenier Basin is undergoing a high rate of conversion of marsh to open water (Figure 4); a 33,900-acre (33 percent) decrease in natural marsh area occurred between 1952 and 1974 (Gosselink et al. 1979). Natural circulation patterns in the basin have been greatly modified by impoundments and by extensive canalization. More than 2,000 acres of marshes have been lost to shoreline erosion, although evidence indicates that shoreline accretion along the Chenier Basin coastline will increase in the future due to the westward drift of Atchafalaya River sediments (Gosselink et al. 1979, Wells and Kemp 1982). Saltwater intrusion has also contributed to the high rate of marsh loss in the basin. Louisiana Highway 82 eliminated the former opening between Grand Chenier and Pecan Island ridges, and thus has virtually eliminated fresh water inflow from the Mermentau Basin into the marshes south of these ridges. An extensive canal network south of Pecan Island which is conncected to the Gulf in several places has allowed salt water to intrude into fresher marshes, and thus has resulted in high marsh losses. In addition, the frequent opening of the Freshwater Bayou Locks due to heavy boat traffic has allowed intrusion of saline waters (10 to 15 ppt) into the eastern Chenier Basin and the holding of fresh water above the Catfish Point structure has allowed saltwater intrusion into the lower Mermentau River on the western end (Wicker et al. 1983).

Severe marsh loss in the Calcasieu Basin is occurring both east and west of Calcasieu Lake (Figure 4). Between 1952 and 1974, 47,000 acres of natural wetlands in the basin have been lost, predominantly to open water. The major causes of wetland loss are subsidence and saltwater intrusion, due to hydrologic alterations (Gosselink et al. 1979). The construction and modification of the Calcasieu Ship Channel has captured the main flow of fresh water from the Calcasieu River, which formerly flowed through Calcasieu Lake. This resulted in increased salinities in the lake and its adjacent marshes. The ship channel also captures most of the river's sediment and nutrient load, resulting in sediment/nutrient deficiencies in the marshes adjacent to the lake and contributing further to their subsidence. Other canals, such as the GIWW and many oilfield location canals, have contributed to the hydrologic alterations in the basin, and

hence to subsidence and impoundment. Adams et al. (1978) reported that the Calcasieu-Sabine Basin has experienced a higher rate of land loss than any of the other Chenier Plain hydrologic units, a rate more comparable to some of the Deltaic Plain units.

SIGNIFICANT DATA GAPS

Canalization is one of the primary factors affecting wetland loss in the study area, yet little has been done to rectify this situation. Occasional compensatory measures occur on abandoned oil field canals via the Section 404 (of the Clean Water Act) permit program, but the effects of these measures on wetland loss is largely unquantified. In addition, such mitigation is piecemeal in nature and there is no overall plan for negating canal-related losses. Future studies could analyze the effectiveness of various mitigation measures; additional studies could serve to identify geographical areas where canal-related losses are most severe and recommend actions which could ameliorate those losses.

Another area where data are lacking is the quantification of benefits associated with wetland preservation. Traditional values are based on man-day and monetary analyses of hunting, trapping, sport and commercial fishing, and recreation. Benefits that have not been quantified include the storm-buffering and water-purifying qualities of wetlands.

MANAGEMENT MEASURES TO ADDRESS PROBLEMS AND OPPORTUNITIES

Various measures have been put forth in recent years that would serve to minimize wetland loss and/or maximize wetland creation. These include freshwater diversions from the Mississippi River or other sources into existing wetlands, maximizing delta development and sediment deposition from the Atchafalaya River, stricter regulation of canal-dredging activities, increased management of existing marshes, and marsh creation via deposition of dredged material. Some of these measures are being implemented to a limited extent at present through existing programs and projects; however, such implementation must be drastically increased in the immediate future if the land loss problem is to be effectively addressed. Day and Craig (1982) evaluated three land loss reduction measures and found that regulatory control of new canals had the highest potential for wetland preservation, followed by maximization of Atchafalaya River sedimentation and controlled diversions on the lower Mississippi River. They predicted that the wetland loss rate could be reduced by 11 to 15 mi^2/yr if no new canals were dredged (data from Turner et al. 1982). A total wetland gain of 6.9 mi^2/yr could be obtained by maintaining the present flowage conditions on the Atchafalaya River (Day and Craig 1982; data from Baumann and Adams 1982, Adams et al. 1978, and Wells and Kemp 1981). If the Atchafalaya were allowed to capture a greater percentage of the Mississippi River flow (the Old River Control Structure presently maintains that figure at 30 percent), land building in Atchafalaya Bay and adjacent estuarine

waters would increase accordingly. Such a scenario would, in effect, utilize sediments which are now being dumped into deep Gulf waters at the mouth of the Mississippi River.

Day and Craig (1982) reported that about 0.4 to 1.2 mi^2/yr would be gained via controlled diversions of the lower Mississippi River (data from Gagliano 1981). However, Gagliano et al. (1973) estimated that 12.3 mi^2/yr could be built if 70 percent of the sediment in the channel were retained for subdelta deposition. The New Orleans District, Corps of Engineers (NODCE), in alternatives developed for this project, estimates that 1.31 mi^2/yr could be built by operating a 100,000-cfs diversion structure for 200 days per year (see section on Mississippi Delta, below).

The periodic dredging of navigation channels to maintain adequate depth produces surplus dredged material which can be used to create marsh. This practice has become increasingly common in the study area in recent years. NODCE estimates developed for this project indicate that 33,000 acres of marsh (660 acres/yr or 1.03 mi^2/yr) could be created over a 50-year period by this method during maintenance of nine existing navigation projects.

Through intensive management of existing wetlands, losses can be reduced via increasing habitat quality as well as quantity. With proper water management capabilities (levees, control structures and/or pumps) and an available source of fresh water, water manipulation could be geared toward maximizing growth of emergent vegetation, eliminating saltwater intrusion, and allowing for ingress and egress of estuarine organisms. Intensive marsh management, once largely limited to public lands, is becoming more widespread on private wetland tracts.

St. Bernard

Fresh water diversions at Bonnet Carre and Caernarvon, already in the planning stages at NODCE under the Mississippi and Louisiana Estuarine Areas Study and the Louisiana Coastal Areas Study, respectively, will reduce the magnitude of saltwater intrusion in the St. Bernard area. A saltwater barrier (sill, closure, or lock) on the MRGO would add to that reduction. NODCE estimates that 100 acres/yr of marsh can be created along the MRGO using material from maintenance dredging activities. NODCE is also investigating the possibility of pumping or barging dredged material from Mississippi Sound, Mobile Bay, and the MRGO to St. Bernard to create marsh, and the building of wave-protection dikes along the shoreline with material pumped from Chandeleur Sound. These measures would all be beneficial to fish and wildlife resources and should be implemented if possible.

Mississippi Delta

The lower Mississippi River and delta area has the most potential for marsh creation because of its close proximity to the sediment source; that

potential generally decreases in other areas in proportion to their distance from the Mississippi River. NODCE has identified seven potential sites for controlled diversions (Figure 5). Each site would have a control structure that would allow 100,000 cfs of Mississippi River water to be diverted into the interdistributary areas; the structures would only operate when the river's discharge exceeded 300,000 cfs (average 200 days/yr) to minimize impacts on navigation and water supply. The plan calls for only one structure to be built and operated at a time; it is estimated that after about seven years of operation the efficiency of the diversion will have decreased, due to the land-building process, such that operation of the structure would no longer be feasible. The marsh creation rate is estimated at 840 acres/yr, or 5880 acres during the seven-year operating life of each structure. The total yield for the seven structures investigated over the 50-year project life would be 41,160 acres. Beause of the diversion, the sediment-carrying capacity in the river would be decreased and, consequently, increased shoaling in the river would occur. This would necessitate more frequent maintenance dredging in the river, which would result in increased cost. However, an added benefit would be the increase in dredged spoil available for marsh creation.

The diversions would have a positive effect on most fish and wildlife resources. However, impacts on species that tend to avoid fresh, turbid water (e.g., oysters, brown shrimp, redfish, spotted seatrout) in the vicinity of the diversions will be negative. Oysters will be particularly vulnerable because salinities less than 1 ppt for 200 days/yr will cause extensive mortality, as will the associated sedimentation on the reefs. In addition, there is a risk that the incoming Mississippi River water would contain high levels of coliforms and other contaminants, which would result in periodic closure of affected oyster-producing areas to commercial harvest.

It is possible that seed grounds could be artificially re-established at a greater distance from the river, where salinities would be more favorable, if suitable bottom conditions can be found. An additional consideration is that the future salinities (without freshwater diversion) may become too high for oyster production; therefore, the net losses to the oyster fishery over the 50-year project life may be negligible.

The impacts to oysters would be greatest at the upstream locations (sites 1 and 2, Figure 5). These sites are adjacent to areas of high oyster production. The sudden influx of fresh water into the saline areas may also have short-term negative impacts on other organisms, but long-term benefits will be realized. Sites 3 and 4 (Figure 5) are largely south of most of the oyster grounds. Circulation of Gulf waters there is, on the average, from northwest to southeast; thus the freshening effect will usually be carried away from the oyster-producing areas. However, during periods of prolonged south to southeast winds this condition may be reversed and negative impacts to oysters could occur. The other three sites are well below any oyster grounds and would pose no negative impacts.

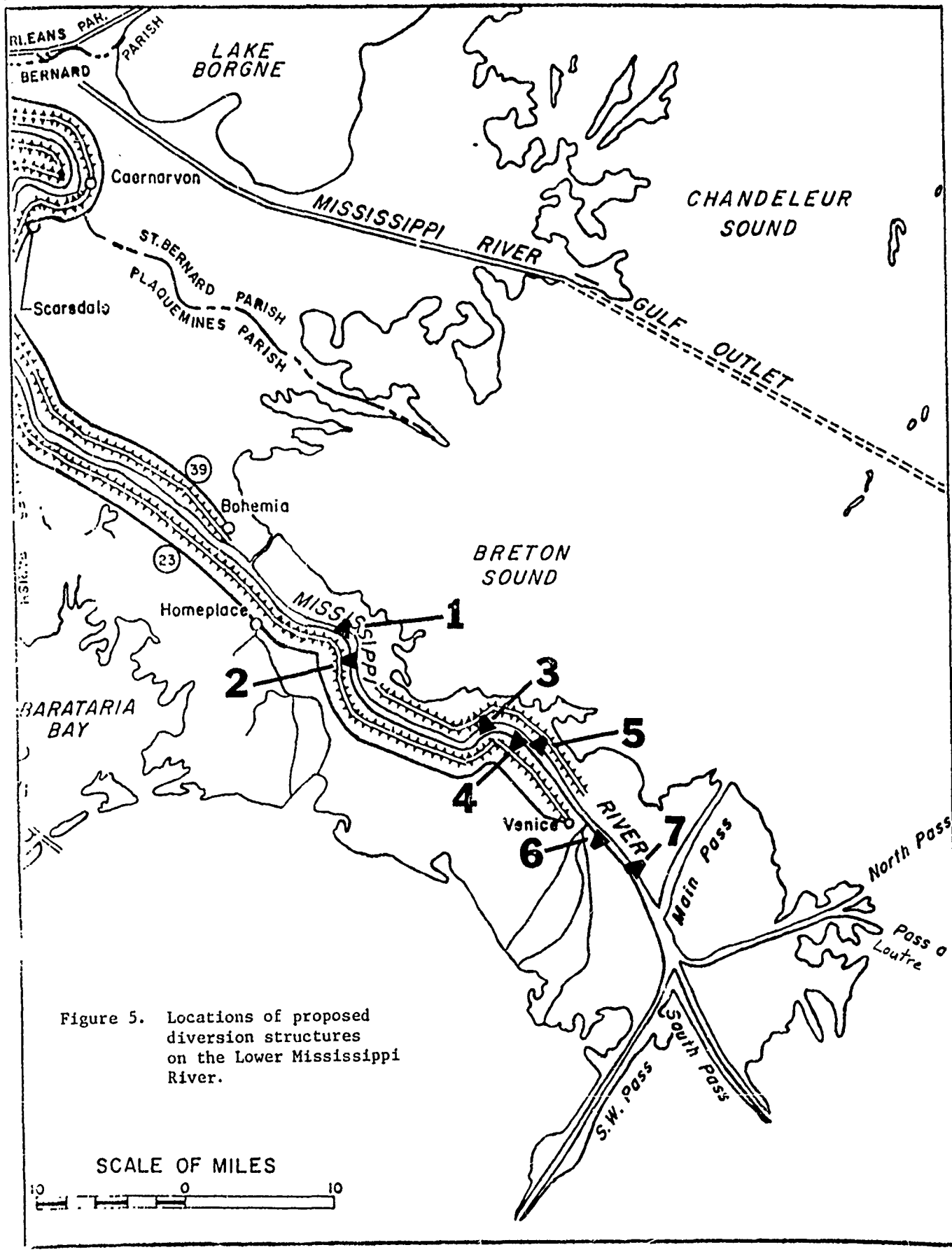

Figure 5. Locations of proposed diversion structures on the Lower Mississippi River.

As an alternative to the 100,000-cfs diversions, NODCE has devised a plan which calls for 25,000-cfs diversions at the same sites (Figure 5). The smaller diversions would not have as great an impact on the oysters and other estuarine species, although the expected total acreage of created marsh (21,000 acres) is only about half that for the 100,000-cfs diversions. For navigational purposes, a flow of at least 200,000-cfs must remain in the river while the structures are operating. Therefore, whenever the river flow increases by 25,000 cfs, additional structures can be opened, i.e., the first structure would be opened when river flow exceeded 225,000 cfs (an average of 300 days/yr) and four structures would be opened when river flow reached 300,000 cfs (an average of 150 days/yr). Each structure would be operated for about 20 years, after which time marsh building would be insignificant; approximately 3,000 acres would be built at each structure.

In addition to the controlled diversions discussed above, a number of uncontrolled diversions has been proposed. Each diversion would involve the excavation of a crevasse in the bank of one of the river's distributaries (passes) through which sediment-laden water would be allowed to flow into a shallow open water area; a delta splay would be formed as the sediment dropped out. NODCE anticipates that each opening will have to be relocated, re-opened, and/or extended about every other year in order to maintain a satisfactory rate of growth. One such crevasse has already been excavated on Delta NWR on Octave Pass, and another is planned for the refuge on Raphael Pass. Three additional sites, two on Pass a Loutre and one on South Pass, were identified by NODCE. They estimate a total of 5,200 acres of marsh to be formed from these five diversions, some of which are already planned for construction under authorities outside the purview of this project. It is believed that additional sites in the active Mississippi Delta could be identified for uncontrolled diversions, and the acreage of created marsh could thus be increased.

Various dredging projects in the lower Mississippi River area (e.g., Southwest Pass, Tiger Pass, Empire to Gulf Waterway) can be used to create marsh with spoil material. This process is already in effect to a limited extent on some projects, and is in the planning stage for others (e.g., Mississippi River, Baton Rouge to Gulf of Mexico, Louisiana, General Design Memorandum Supplement No. 2, and Mississippi River Deep Draft Channel to Gulf of Mexico, Louisiana). It is apparent that a great deal more marsh could be created in this way than is now occurring. NODCE estimates that 214 acres/yr could be created at Southwest Pass and 13 acres/yr at Tiger Pass via spoil disposal.

Another marsh creation technique that may be feasible in the Delta area is hydraulic pumping of slurry (mixture of mud and water from the river bottom) into diked disposal areas, where elevations conducive to marsh establishment would be maintained. Loss of newly created marsh to erosion and impacts to oysters would be minimized through this method. NODCE estimates that 360 acres/yr (18,000 acres total) could be created in this fashion.

Erosional loss along the coastline could be minimized by construction of artificial barriers or breakwaters on or adjacent to the existing shorelines. The barging of spoil disposal material from upstream areas for marsh creation has also been considered; such "double handling" has been found to be economically infeasible in the past.

Maintenance of a 40-foot depth in Southwest Pass results in less frequent overbank flooding as well the dumping of approximately 29 percent of the river's sediment (Gagliano et al. 1973) into deeper Gulf waters. More marsh could be created naturally in the delta if the controlling depth were decreased to 20 feet to allow for more frequent overbank flooding and/or the navigation channel changed from Southwest Pass to one of the eastern passes (e.g., Main Pass) so that sediment would be deposited naturally into shallower waters to build marsh. By the same token, the MRGO, which now supports very little ship traffic, could become the main navigation channel while the Mississippi River below New Orleans would be allowed to revert to natural processes, free from the current navigation constraints. Gagliano et al. (1973) suggested construction of a closure at the mouth of Pass a Loutre so that its sediment (32 percent of the total flow) could be diverted into adjacent marshes and open water areas. The closure or constriction of South Pass has been recommended by the FWS and NMFS as a means of diverting additional freshwater and sediments to the other passes (e.g., Pass a Loutre and Main Pass).

Terrebonne-Lafourche

Measures that would serve to reduce land loss in the Terrebonne-Lafourche area would include increasing freshwater inflow, reducing saltwater intrusion, creation of marsh via disposal of dredged material, and/or reduction of canal-related losses. Various plans to increase freshwater inflow have been proposed. One option is the use of Bayou Lafourche to divert Mississippi River water to the Terrebonne-Lafourche wetlands. To divert any large quantities of fresh water would require enlarging the existing channel. The capacity of the existing channel is approximately 2500 cfs, although it presently receives a maximum discharge of 300 cfs (Gagliano et al. 1973). The flow could be increased to 2500 cfs without any channel work, and the feasibility of increasing the channel capacity to accommodate higher flows should be investigated. NODCE has investigated the possibility of using the GIWW as a conduit for fresh water from the Atchafalaya or Mississippi Rivers to near Houma, La., from whence the fresh water could be distributed via natural streams (Bayou Terrebonne, Bayou Grand Caillou, Bayou du Large, etc.) to the marshes to the south. To accomplish this, however, it would require that water levels near the source be raised three to four feet to establish a gradient. Such high water levels would result in marsh deterioration due to submergence of those wetlands near the diversion point. An alternative would be complete isolation of the GIWW from all adjacent water bodies where a head differential would be created. This would require a complex system of levees, pumps, and control structures which would probably not be feasible

at this time. Such intensive water control and management, however, may be warranted at some time in the future.

Marshes on the western portion of Terrebonne Parish are experiencing lower rates of marsh loss than the rest of the parish due to the influence of the Atchafalaya River. The proposed extension of the Avoca Island Levee, however, would eliminate much of this freshwater inflow and thus increase the rate of marsh loss. Therefore, implementation of alternatives to the levee extension would be a measure to reduce future marsh loss in western Terrebonne Parish.

NODCE has investigated the pumping of slurry from Mississippi River bottom sediment via pipeline to the Terrebonne-Lafourche area. The slurry would be pumped into diked areas to build marsh. Two such pipelines were investigated. One pipeline would begin at about river mile 35, near Nairn, and terminate near Bayou Lafourche; approximately 10,000 acres of marsh would be created on each side of Bayou Lafourche between Cut Off and the Gulf of Mexico. The second proposed route would extend from about river mile 115, near Ama, to the Bayou Petit Caillou area; about 15,000 acres of marsh would be created along Bayou Petit Caillou and Bayou Terrebonne between Montegut and Cocodrie. Total marsh creation from these two pipelines would be 25,000 acres, or 500 acres/yr.

Additional marsh creation could be accomplished during maintenance dredging of the Barataria Bay Waterway and the Houma Navigation Canal. NODCE estimates that 6,200 acres of marsh (124 acres/yr) can be created by disposal of spoil dredged from those channels over their project life. The Barataria Bay Waterway and Houma Navigation Canal also serve as avenues for saltwater intrusion. Installation of a lock, control structure, or saltwater barrier on each of these waterways would undoubtedly do much to reduce marsh loss.

The construction of canals in the Terrebonne-Lafourche area has contributed significantly to the land loss problem there. Regulation of canal dredging has improved considerably in the last decade, especially with regard to avoiding hydrologic alterations and utilizing existing waterways and/or directional drilling when practicable. However, there has been little progress toward restoration of areas damaged by canal dredging. Backfilling of canals with existing spoil has merit in that the canal bottom is usually raised into the photic zone and former spoil areas are allowed to revegetate with marsh plant species. Due to compaction and oxidation of spoil material, there is never sufficient material to completely fill the canal; in some cases, such as in flotant marsh, there may not be enough spoil to justify any backfill attempt. The possibility of requiring oil companies to use barged spoil to restore canals should be thoroughly investigated. In addition, a plug and partial backfill should be required whenever feasible. Spoil material from maintenance dredging operations on the Houma Navigation Canal, Barataria Bay Waterway and GIWW can be pumped into abandoned canals near those waterways. Existing canals that are

causing hydrological problems should be identified and the problems rectified.

Chenier Basin

The productivity of the marshes of the Chenier Basin is less than optimum, due largely to a lack of fresh water input; measures which would increase the flow of fresh water from the Mermentau Basin should be implemented. Several such measures have been proposed for consideration as part of the Grand and White Lakes Water Management Study (U.S. Army Corps of Engineers 1983a). These measures include: (1) install a control structure near the south shore of White Lake to allow increased fresh water inflow into the Rollover Bayou system, (2) increase drainage under Louisiana Highway 82 by increasing the number and/or size of culverts or by removing or modifying the existing structures that impede flow in waterways that pass under the highway, (3) increase the outflow through Vermilion Locks, and (4) increase the capacity of the Catfish Point and/or Schooner Bayou structures. Implementation of the first two measures would increase sediment and nutrient input into the Chenier Basin and reduce saltwater intrusion there. The increase in fresh water would also allow for increased water management in impounded areas to encourage the growth of emergent plants; such management should be encouraged. Marshes in the Mermentau Basin, presently being stressed by excessively high water levels, would be benefitted by increased outflow associated with implementation of the four measures referenced above.

Calcasieu Basin

A saltwater barrier (control structure, sill, or lock) on the Calcasieu Ship Channel north of Cameron would do much to alleviate the problems of saltwater intrusion and subsequent marsh loss in the Calcasieu Basin. Also needed is an increase in freshwater inflow into the marshes on both sides of Calcasieu Lake. On the east, sufficient amounts of fresh water should be available from the Mermentau Basin. Increased flows into the Calcasieu Basin could be accomplished by increasing the flows through the Calcasieu Locks on the GIWW. Additionally, the feasibility of diverting fresh water from the GIWW southerly into the marshes east of Calcasieu Lake is being evaluated (U.S. Army Corps of Engineers 1983a). This increase in flow, together with the Soil Conservation Service levee along the eastern shore of Calcasieu Lake, should alleviate marsh loss being caused by saltwater intrusion in the eastern Calcasieu Basin.

Saltwater intrusion in the western Calcasieu Basin is one of the principal factors contributing to the high rate of marsh loss there. Three natural channels connect Calcasieu Lake and the Calcasieu Ship Channel with the adjacent marsh to the west. Saltwater intrusion from Calcasieu Lake has recently been curtailed by control structures constructed on Sabine NWR. However, Black Lake Bayou remains open to the saline waters of the Calcasieu Ship Channel. A control structure on Black Lake Bayou would reduce saltwater intrusion into the Black Lake area, which may have had the

highest rate of marsh loss (21.1 acres/mi^2/yr calculated from Wicker et al. 1981) in the study area between 1952 and 1974 (Adams et al. 1978). With such a closure in place, access to the Black Lake area would still be possible through Alkali Canal and the GIWW. Intensive water management in the marshes of the western Calcasieu Basin could be geared toward re-establishment of emergent plants, increased fresh water supply (from the GIWW), and reduction of saltwater intrusion. Such management measures are already established or proposed on some private lands.

The possibility of diverting fresh water from the Sabine River into the Calcasieu Basin should be investigated. Flow on the Sabine is regulated by discharges from Toledo Bend Reservoir; those discharges vary with power generation needs. Thus, the Sabine River flow from about June through January is considerably higher now than it was before the dam was constructed (Gosselink et al. 1979). The result is a freshwater surplus in Sabine Lake during those months. This excess fresh water could be diverted to the Calcasieu Basin during those months when salinity intrusion problems are greatest there.

Dredged material from the maintenance of the Calcasieu Ship Channel and the GIWW can be used to create marsh adjacent to those channels; such action has already occurred on a limited scale. NODCE estimates that 4,100 acres (82 acres/yr) can be created over the 50-year project life from the Ship Channel and 350 acres (7 acres/yr) from the GIWW between the Atchafalaya and Calcasieu Rivers.

FUNDING NEEDS FOR FISH AND WILDLIFE STUDIES

Additional fish and wildlife studies will be necessary as this study proceeds into later stages of planning. These include studies needed to fill existing data gaps (as identified in a previous section), an additional Planning Aid Report for the evaluation and selection of alternatives, a draft Fish and Wildlife Coordination Act (FWCA) Report, and a final FWCA Report. The estimated funding requirements for the above four items are $40,000, $32,000, $32,000, and $10,000, respectively, or a total of $114,000.

PLANNING OBJECTIVES AND CONSTRAINTS

The FWS believes that virtually any measures that result in marsh creation, restoration, or preservation would be beneficial to fish and wildlife resources. Our objective would be to maximize efforts in areas that serve as habitat for species of federal concern, e.g., migratory waterfowl, Species of Special Emphasis, and threatened and endangered species. Since migratory waterfowl have shown a preference for fresh and intermediate marsh types, for example, we would favor alternatives which concentrate on those wetlands types. However, most of the wetland types in the study area serve as habitat for some Species of Special Emphasis.

Some of the marsh creation measures may have short-term negative impacts on bottom dwelling organisms, such as clams and oysters, due to the large influx of sediment and/or fresh water. However, it is believed that these organisms will, in most cases, be able to recolonize other locations in a given estuary where salinity, turbidity, and/or bottom conditions are more favorable. Overall fish and shellfish yields will benefit from the net gain in marsh acreage. Some negative impacts may also result from structural measures that involve habitat alteration due to rights-of-way, control structures, channel works, etc. The associated benefits, however, are expected to far outweigh such negative impacts.

Any work performed on or affecting National Wildlife Refuges will require prior FWS approval. This is to insure that the work is consistent with the purposes for which the land was acquired. In addition, any actions having potential impacts on endangered species or their habitat may require consultation with this agency under Section 7 of the Endangered Species Act.

FUTURE WITHOUT-PROJECT CONDITIONS

Acreage projections (developed by NODCE) for the study area under future without-project (FWOP) conditions are presented in Table 4. These projections are based on the continuation of existing wetland-loss trends for the various habitat types, and the assumption that various authorized Corps of Engineers projects (e.g., Mississippi Delta Region Project, New Orleans to Venice, Louisiana, Hurricane Protection Project) are in place. Some of these projects include marsh creation features. All wetland habitat types are expected to suffer acreage losses; open water habitats will experience a corresponding gain.

Resource use and harvest estimates for selected commercial and recreational activities under FWOP conditions are presented in Table 5. The methodology for this type of analysis has been discussed in detail by USFWS (1983) and USFWS (1980). Predictions for the year 2040 assume a direct relationship between wetland acreage and resource use or harvest. The figures presented herein are rough estimates based on existing available data; a more detailed analysis of resource use can be conducted during later planning stages.

The major activities that take place in the study area (i.e., commercial and recreational fishing, waterfowl hunting, and trapping) are all predicted to show substantial losses over the project life (Table 5). Commercial fishery landings are expected to decrease from 1.6 billion pounds to 1.0 billion pounds, a $67 million loss in value, by the year 2040. The number of recreational fishing trips is expected to show a 33 percent decrease, from 3 million to 2 million trips, for a $4 million decrease in value. Waterfowl hunting is expected to decrease by about 300,000 man-days ($12 million dollar loss), and fur and alligator combined

Table 4. Acreage projections by habitat type for future without-project conditions for the Louisiana Coastal Area.

Habitat Type	Target Year (acres X 1000)				
	1978	1990	2000	2020	2040
Forested wetlands	637.4	602.3	569.3	512.5	454.2
Emergent marsh					
Fresh/intermediate	1183.3	1098.1	1056.7	949.0	863.4
Brackish	911.5	865.9	801.8	671.8	579.2
Saline	434.3	375.6	331.9	292.0	258.9
Total marsh	2529.1	2339.6	2190.4	1912.8	1701.5
Open water	5542.4	5767.0	5949.2	6285.6	6553.2
Total	8708.9	8708.9	8708.9	8708.9	8708.9

Table 5. Resource use and harvest projections for selected activities in the Louisiana Coastal Area under future without-project conditions.

Activity	Baseline[a]		2040[a]	
	Quantity ($\times 10^6$)	Value ($\times 10^6$)	Quantity ($\times 10^6$)	Value ($\times 10^6$)
Commercial fishing[b]	1,550 lbs.	$205.0	1,040 lbs.	$138.0
Recreational fishing[c]	3.0 trips	12.5	2.0 trips	8.4
Waterfowl hunting[d,e]	0.956 man-days	39.2	0.663 man-days	27.2
Fur trapping[d]	0.982 pelts	7.3	0.696 pelts	5.2
Alligator harvest[d]	0.010 skins	2.1	0.007 skins	1.5
Total value		266.1		180.3

a. Baseline quantity values, obtained from various sources (cited below), were divided by 1978 acreages to obtain quantity/acre; this figure was then applied to the 2040 acreage values to obtain an estimate for that year.

b. Based on 1978 to 1983 mean of commercial landings and dockside values, from NMFS 1980b, 1982, and 1984.

c. Quantity of trips from NMFS 1980a; value per trip from U.S. Army Corps of Engineers 1983b.

d. From USFWS 1983.

e. Value per man-day for waterfowl hunting from USFWS 1980.

harvest would decrease by 289,000 skins (worth $2.7 million). The total value for all activities is expected to decrease from $266 million to $180 million, or a loss of $86 million (32 percent).

CONCLUSIONS

All of the possible solutions presented herein would be beneficial to fish and wildlife resources. Most have only minor adverse environmental impacts and none would be considered infeasible on environmental grounds. All measures should be investigated and the best combination of alternatives should be found.

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LOUISIANA COASTAL AREA, LOUISIANA

INITIAL EVALUATION REPORT

ON

LAND LOSS AND MARSH CREATION

APPENDIX B

LETTERS AND COMMENTS RECEIVED ON THE PUBLIC MEETING
NOTICE AND AT PUBLIC MEETINGS
ON AUGUST 27 IN BELLE CHASSE, AUGUST 28 IN HOUMA, AND
AUGUST 30, 1984, IN CAMERON, LOUISIANA

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APPENDIX B

SUMMARY OF ORAL COMMENTS ON LAND LOSS AND MARSH CREATION PRESENTED AT PUBLIC MEETINGS

The meetings were attended by 241 persons, and 59 expressed their views. Federal, state, and parish agencies, environmental groups, and individuals were unanimous that the land loss problem is extremely serious and that the Corps should move as quickly as possible to implemer solutions to reduce land loss. Most speakers objected to the low alue used in evaluating proposed solutions and recommended that the Coprs cooperate with state and parish agencies in developing a realistic evaluation method. The method should include the value of the marsh as a buffer against storms, its esthetic, ecologic and social values, and the present value of the infrastructure that will be lost or damaged. Most of the Federal and state agencies opposed the use of the proposed freshwater diversion overflow areas at Big Mar near Caernarvon and Davis Pond near Luling in the feasibility study on Freshwater Diversion to Barataria and Breton Sound Basins as reservoirs for emergency water supplies. The reservoirs would destroy nearly 9,000 acres of marsh and jeopardize the freshwater diversion projects. Numerous individuals requested that the Corps do something quickly before they lose all of their land.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
9450 Koger Boulevard
St. Petersburg, FL 33702

October 1, 1984 F/SER112/PK/JL:gog
409/766-3699

Colonel Eugene S. Witherspoon
District Engineer, New Orleans District
Department of the Army, Corps of Engineers
P. O. Box 60267
New Orleans, LA 70160

Dear Colonel Witherspoon:

This is in reference to the three July 1984 Notices of Study Findings (Notices) and the Announcment of Public Meetings by the Corps of Engineers (Corps) for the Louisiana Coastal Area Study initial evaluations of Water Supply, Land Loss and Marsh Creation, and Shore and Barrier Island Erosion. Alternatives are discussed in each Notice. The National Marine Fisheries Service (NMFS) has reviewed the Notices and offers the following comments for your consideration.

We feel that the lack of sufficient freshwater and sediment inflow to sustain the coastal marshes is among the most serious marine fishery issues facing the Louisiana coast. Without sufficient freshwater and its accompanying sediment supply, wetlands will continue disappearing at an ever increasing rate beyond the most recent estimate of 32,000 acres per year, or over 3 acres per hour. Measures such as those proposed in these Notices should be studied and the most beneficial ones implemented as soon as feasible in order to stem the loss of wetlands.

Regarding the Water Supply proposals, one of the alternatives for the Houma area typifies the present conditions causing marsh loss. The Houma Navigation canal, according to the Notice, has allowed saltwater intrusion into the area marshes and jeopardized the fresh water supply for Houma. However, the Notice then states that the Corps has ruled out a saltwater barrier in that navigation canal because a barrier "poses some serious environmental problems", in that it would "create a barrier to the transport of estuarine-dependent fish and shellfish species." Nevertheless, we believe that a saltwater barrier could be designed to allow for continued ingress and egress of estuarine-dependent organisms while still minimizing salt water intrusion and allowing navigation. Therefore Plan 6, or a modification of it, to prevent the excessive saltwater intrusion should not be excluded but should be retained for more detailed study.

The NMFS is concerned that Plans 13 and 14 for the River Parishes, which the Corps recommends be retained for more detailed study, could eventually be in direct conflict with the intended diversion of freshwater into the marshes as proposed by the Corps in another part of the Louisiana Coastal Area Study. Plan 13 or 14 could cause delay(s) in the construction, and/or conflict in the operation of, facilities that would divert the direly needed freshwater flows to benefit the marshes of Lafourche, Jefferson and Plaquemines Parishes. When previously commenting on those two proposed freshwater diversion projects, the

NMFS emphasized that the facilities and easements should be sufficient for any later increase of freshwater inflow needs. In addition to placing conflicting operation demands upon the water diversion structures, the reservoirs would remove some wetlands. Plan 12 also would destroy some wetlands as presently described in the Notice. In view of the above, the NMFS recommends that Plans 12, 13, and 14 be eliminated from further study.

Increased adverse impacts to estuarine-dependent fishery species would occur from Plans 24, 25, and 26 by blocking or further restricting access by those species that are currently allowed to access the Grand and White Lakes area and by causing even further adverse impacts to the area marshes with elevated water levels. Therefore, the NMFS recommends that Plans 24, 25, and 26 be eliminated from further study.

In regard to the Land Loss and Marsh Creation proposals, NMFS supports the alternatives suggested to preserve and enhance the dwindling coastal wetland resources. Two procedures, (1) diverting a portion of the 189 million tons of sediment carried by the Mississippi River each year and (2) placing dredged materials to elevations conducive to the establishment of marsh vegetation, should restore some marshes and retard erosion. We therefore endorse the Corps' proposal that these alternatives be investigated in further detail.

Concerning the Shore and Barrier Island Erosion proposals, the barrier islands are a thin but effective outer barrier of defense against the estuaries becoming open Gulf waters. These barrier islands must continually have sediment replenishment to endure. Various stabilization methods such as beach nourishment and dune construction, revetments, breakwaters, and revegetation are intermediate measures that slow the erosion and subsidence processes caused by lost sediment nourishment. Implementation of such stabilization plans, is necessary to prevent the erosion and/or disappearance of the eight areas specified in the Shore and Barrier Island Notice. The only exception to the general coastal erosion occurring in Louisiana is the area being sustained and accreted by sediment flows from the Atchafalaya River complex. Thus, the NMFS supports plans to protect the barrier islands, peninsulas and beaches that separate the open Gulf from the nation's largest assemblage of complex estuarine systems that are so vital to marine fishery resources.

In summation, the NMFS supports study completion and implementation as soon as possible of those plans that would prevent or retard the increasing estuarine losses of the Louisiana coast. We also believe the barrier island protection could be enhanced with additional freshwater inflows to transport sediment. Finally, we reiterate that Water Supply Plans 12, 13, 14, 24, 25, and 26, which we believe would cause adverse environmental impacts to marine fishery resources, should be eliminated from further study.

Thank you for the opportunity to review the study findings.

Sincerely yours,

for Richard J. Hoogland
Chief, Environmental Assessment
Branch

United States Department of the Interior

FISH AND WILDLIFE SERVICE

POST OFFICE-BOX 4305
103 EAST CYPRESS STREET
LAFAYETTE, LOUISIANA 70502

STATEMENT OF U.S. FISH AND WILDLIFE SERVICE
PRESENTED AT PUBLIC MEETINGS TO DISCUSS STUDY
FINDINGS REGARDING WATER SUPPLY, LAND LOSS AND
MARSH CREATION, AND SHORE AND BARRIER ISLAND
EROSION IN THE LOUISIANA COASTAL AREA -
AUGUST 27, 28, AND 30, 1984

Colonel Witherspoon, distinguished guests, ladies and gentlemen, my name is David Fruge, Field Supervisor of the Lafayette, Louisiana, Field Office of the U.S. Fish and Wildlife Service. I am presenting this statement on behalf of Mr. James W. Pulliam, Jr., Regional Director of the Fish and Wildlife Service in Atlanta, Georgia. My statement represents the views of the Service on the alternatives being considered for water supply, land loss, and shore and barrier island erosion in the Louisiana Coastal Area.

Coastal Louisiana is experiencing dramatic habitat changes. Louisiana's coastal marshes are being lost at a rate exceeding 25,000 acres per year, Louisiana's shoreline and barrier islands are breaking up and retreating at an alarming rate, and much of the fresh water and sediments which built and nourished its coastal wetlands are now funneled into the Gulf of Mexico. This deterioration is of great concern to the Service because of the national importance of Louisiana's coastal wetlands to migratory waterfowl and other migratory birds, fur animal and alligator harvest, and sport and commercial fisheries.

We concur with the Corps' identification of the nature and severity of the land loss problems in coastal Louisiana. We also agree that the alternatives presented in the Notice of Study Findings for the Land Loss and Marsh Creation Study would serve to create marsh and, as such, would greatly benefit fish and wildlife resources. Therefore, we concur that investigation of marsh-creation alternatives such as placement of dredged material, diversion of sediment-laden Mississippi River water, and transport of bottom sediments from Chandeleur Sound and from the Mississippi River to nearby subsiding areas should continue. However, alternatives other than marsh-creation should be considered. Measures which would slow the rate of marsh loss and thereby preserve existing marsh were recommended in our June 18, 1984, Planning Aid Report, and include construction of saltwater barriers on the Mississippi River - Gulf Outlet, the Houma Navigation Canal and other major navigation channels, installation of a plug or sediment barrier at the mouth of Pass-a-Loutre, and increasing freshwater flows into Bayou Lafourche.

Regarding the Water Supply Study, the Fish and Wildlife Service believes that lack of adequate freshwater inflow into coastal marshes may be the most serious water supply problem in the study area. Corps of Engineers navigation and flood control projects have contributed greatly to this problem. We believe that the present study should address this problem and not be limited to municipal/industrial water supply problems.

In the Houma area, construction of a saltwater barrier across the Houma Navigation Canal (Plan 6), was eliminated from further study because of alleged environmental problems. However, the Service believes that this plan would have extensive positive impacts to fish and wildlife resources; these benefits would be based on a reduction in marsh loss and a decrease in the conversion of fresher marshes to more saline marsh types. The barrier could be designed to allow ingress and egress of estuarine organisms. Any negative construction-related impacts would be small in relation to the positive impacts associated with such a structure. In addition, the economic benefits and costs of this plan are in line with Plan 9, which was recommended for further study. Therefore, the Service recommends that Plan 6 be retained for more detailed study.

We agree with the Corps' assessment that water supply Plans 13 and 14 would have significant environmental impacts. According to members of your staff, the proposed reservoirs would impact approximately 7,425 acres of fresh marsh at Davis Pond and 7,000 acres of intermediate marsh at Big Mar, both sites for future freshwater diversion projects. These areas serve as valuable habitat to many species of fish and wildlife. Depending on the depth and duration of flooding, use of those areas for water supply purposes could have extreme adverse effects on wetland-associated wildlife. The wetlands to be affected at the Davis Pond site include marshes located on the Salvador Wildlife Management Area, operated by the Louisiana Department of Wildlife and Fisheries. In addition, such dual use of the freshwater diversion sites may lead to conflicts between uses at certain times. For example, communities desiring to use these sites for water supply may apply pressures to the operating agency to cause a delay or postponement of freshwater releases into the marshes. Further, we are seriously concerned that detailed studies of the Davis Pond and Big Mar sites for use as water supply reservoirs may delay the critically needed freshwater diversion projects now being planned for these two sites. Therefore, we recommend that Plans 13 and 14 be eliminated from further study.

Based on recent changes in irrigation and cropping patterns in the Mermentau Basin, we question whether existing freshwater supplies will be inadequate to meet future demands. Therefore, we request that further studies be carefully designed to accurately assess water supply needs in that basin.

With regard to the Shore and Barrier Island Erosion study, the Corps of Engineers has recommended further study of erosion control plans for the Terrebonne Parish Barrier Islands (comprised of the Timbalier Island/ Isles Derniers complex) and for Holly Beach and adjacent beaches.

The Service supports plans to prolong the life of the Terrebonne Parish Barrier Islands which provide for:

- o filling to increase the width of the islands;
- o planting of natural vegetation and erecting sand fencing to stabilize dunes; and
- o implementing a beach nourishment program that avoids near-shore borrow areas.

The Fish and Wildlife Service also supports plans at Holly Beach and vicinity which include:

- o building dunes;
- o planting native vegetation and erecting sand fences;
- o constructing elevated walkways over dunes; and
- o initiating a beach nourishment program.

In a letter to the Corps, dated April 30, 1984, the Fish and Wildlife Service identified several data gaps including:

- o an evaluation of measures designed to reestablish longshore sediment transport at the mouths of major navigation channels; and
- o an evaluation of measures to preserve the remaining natural shell reefs in Atchafalaya Bay and in the Gulf of Mexico near Marsh Island and Point an Fer Island.

The Service reiterates its recommendation that the Corps address these and other information needs identified in the Service's April 30 letter.

Portions of the barrier island and shoreline areas recommended for further study are units of the Coastal Barrier Resources System, which was established under the Coastal Barrier Resources Act of 1982. If the Corps of Engineers intends to expend Federal funds within a unit of the Coastal Barrier Resources System, a letter requesting consultation under provisions of the Coastal Barrier Resources Act should be sent to the Service's Regional Director in Atlanta, Georgia.

In conclusion, the Fish and Wildlife Service believes that the alternatives considered in the Land Loss and Marsh Creation and the Shore and Barrier Island Erosion studies would substantially benefit fish and wildlife resources in coastal Louisiana, and recommends that the scope of alternatives for these studies be broadened. The Service also recommends that those Water Supply alternatives with severe adverse environmental impacts be eliminated from further study; these include Plans 12, 13, 14, 24, 25, and 26.

We sincerely hope that many of the habitat enhancement measures being considered will eventually be implemented so that the rich renewable resources of the Louisiana coastal region can be maintained for future generations.

Thank you.

United States Department of the Interior
NATIONAL PARK SERVICE
SOUTHWEST REGION
P.O. Box 728
Santa Fe, New Mexico 87501

IN REPLY REFER TO:

L7619(SWR-PE)

OCT 5 1984

Colonel Eugene Witherspoon
District Engineer
New Orleans District
U.S. Army Corps of Engineers
Post Office Box 60267
New Orleans, Louisiana 70160-0267

Dear Colonel Witherspoon:

We have received Notices of Study Findings for three Louisiana Coastal Area Studies: Water Supply, Shore and Barrier Island Erosion, and Land Loss and Marsh Creation. We are supplying the following comments to you on a technical assistance basis.

Regarding the Water Supply Study, the study has identified six water supply problem areas. Of these, four are of immediate concern to the National Park Service (NPS) affecting communities and the ecological systems which support them as part of the delta region. Under the provisions of Public Law 95-625, November 10, 1978, which created Jean Lafitte National Historical Park, the NPS is concerned with the preservation of the natural and historical resources of the delta region. We recognize the need for long-term planning and implementation of programs to meet the freshwater needs of the people of the delta region, and we applaud this preliminary study.

Any freshwater delivery system, however, should be designed in such a way as to disrupt the natural wetland ecosystem, so vital to the delta's unique cultural heritage, as little as possible. The deterioration of this ecosystem and threats to its future viability have been amply documented, and the need for remedial solutions to these problems is recognized by the Corps. We are especially concerned, therefore, with the proposal to use the Davis Pond Freshwater Diversion to create a reservoir at the expense of 7,425 acres of freshwater marsh. Not only would such a project undo much of the good which is anticipated to accrue from the diversion project, but it would directly affect the important Barataria estuary, and deplete the watershed of the Barataria Unit of Jean Lafitte National Historical Park.

Regarding the Land Loss and Marsh Creation and Shore and Barrier Island Erosion Studies, no more critical threat to the integrity of the historical and natural resources of the delta region exists than the loss of marsh, swamp, and barrier beaches to erosion caused by man-made alterations to the environment. We encourage the Corps to aggressively pursue regulatory and structural measures which will help slow this catastrophic deterioration. It is important that

research be funded to establish the true value, economic, social, and otherwise, of the wetlands being lost. In this way, the Corps' cost/benefit ratios, which they recognize are based on inadequate data, can be re-evaluated, and the public and its governmental representatives be given a more accurate assessment of the problems and the true costs and benefits of solutions.

We appreciate the opportunity to provide these comments.

Sincerely,

Eldon K. Reyer

Associate Regional Director,
Planning and Cultural Resources,
Southwest Region

28 Aug 84

Good evening, ladies and gentlemen, I am David Chambers with the Louisiana Department of Natural Resources. Our agency has been designated by Governor Edwards to represent Louisiana in coastal matters affecting our state.

At the state level we are very concerned with the preservation and management of our remaining coastal wetlands and the wide array of valuable resources associated with them. As most of us here tonight are aware, we are losing our coastal barrier islands and marshes at an alarming rate. We must take steps to stop the loss of these coastal lands and to preserve their beauty and productivity for future generations to come.

The state has been actively pursuing and developing a coastal protection program to address these concerns. We are presently in the process of designing and implementing projects to help offset the impacts of coastal land loss. Examples of such projects include barrier island and beach restoration, freshwater diversion, marsh creation, and wetland management programs.

These projects are designed to complement the efforts of federal government agencies as well as those of parish or local governments. We would like to commend the Corps of Engineers for recognizing the severity of our coastal land loss problems and for undertaking these studies aimed at identifying potential solutions to these serious problems facing our coastal parishes.

The three studies being discussed tonight have the potential to reduce erosion, saltwater intrusion, and land loss, to improve fish and wildlife productivity, and to enhance our available freshwater supplies. We support the proposed recommendations for futher study with the exception of Plans 13 and 14 which propose the use of the freshwater diversion sites at Davis Pond and at Big Mar as freshwater storage locations. We believe that any proposal to consider freshwater storage at these locations will result in further delays in implementing the freshwater diversion project in these basins where freshwater inputs are desperately needed. Therefore we request that the Corps of Engineers delete Plans 13 and 14 from further consideration.

It is appropriate at this time to recognize and applaud the coastal protection efforts of the Terrebonne Parish government and the elected state and federal officials representing this area. The Department of Natural Resources through its Coastal Protection Program, will work closely with Terrebonne Parish and other coastal parishes in implementing a coastwide plan to preserve and maintain our disappearing wetlands, beaches, and barrier islands. Thank you. Colonel Willis.

STATEMENT
PRESENTED TO
NEW ORLEANS DISTRICT
U.S. ARMY, CORPS OF ENGINEERS

ON

LOUISIANA COASTAL AREA, LOUISIANA

SHORE AND BARRIER ISLAND EROSION
LAND LOSS AND MARSH CREATION
AND
WATER SUPPLY

INITIAL EVALUATION STUDIES

AUGUST 28, 1984
HOUMA, LOUISIANA

IN BEHALF OF
THE STATE OF LOUISIANA

BY

MARTY J. CHABERT
ASSISTANT SECRETARY
OFFICE OF PUBLIC WORKS
DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

ARTHUR R. THEIS
DEPUTY CHIEF ENGINEER

COAN BUECHE
CHIEF, FEDERAL PROJECTS
SECTION

PUBLIC MEETING CONCERNING:

Louisiana Coastal Area, Louisiana Land Loss and Marsh Creation Initial Evaluation Study

Louisiana Coastal Area, Louisiana Shore and Barrier Island Erosion Initial Evaluation Study

Louisiana Coastal Area, Louisiana Water Supply Initial Evaluation Study

INTRODUCTION

This statement has been prepared by the State of Louisiana, Department of Transportation and Development, Office of Public Works. We are pleased to have the opportunity to present this statement to the New Orleans District, Corps of Engineers, in response to the notice of public meetings which invited comments on the initial evaluation of the three (3) studies.

The Department of Transportation and Development, Office of Public Works, is the engineering and planning agency for the State of Louisiana which has the responsibility of formulating plans and promoting and constructing projects for the timely and orderly development of the vast water resources of the State of Louisiana. In carrying out these broad responsibilities, the Office of Public Works maintains a close liaison with the U.S. Army, Corps of Engineers. We are gratified with the long cordial relationship which has been achieved and we are looking forward to a continuation of this joint effort which is mutually beneficial to the nation and the State of Louisiana. I would first like to address the Land Loss and Marsh Creation and Shore and Barrier Island

Erosion Initial Evaluation Studies since these studies are so inter-related and then separately discuss the Coastal Water Supply Initial Evaluation Study.

I would like to start by congratulating the Corps on these studies. I think the two studies in question show a good understanding of the natural and man made problems of land loss and erosion of our coastal areas. Our office has long thought that some structural measures were necessary to retard the erosion of Louisiana's coastal areas. A structural solution that we think deserves further looking into is the development of closures in the barrier island chains to reduce salt water intrusion in Terrebonne Bay, Timbalier Bay, and Barataria Bay. These closures could reduce the salt water intrusion into these areas to allow for re-vegetation and re-establishment of these marsh areas that are being lost at a faster rate than anywhere else along the coast. We are pleased, however, to see both structural and non-structural solutions to erosion and marsh creation offered in these studies.

The problem we have is that all the good work done in the studies is offset by an inappropriate method for determining benefit/cost ratios which does not adequately address the coastal realities of our state. The method does not accurately estimate the value of our marshes and barrier islands and leads to low benefit/cost ratios which severely underestimate the value of the projects in question.

A new method for determining the benefits of our wetlands must be developed that will take into account their value as storm buffers to human settlements along the coast and their esthetic, ecological, and social values to Louisiana. Furthermore, the

present method does not seem to take into account the value of the infrastructure that will be lost if the coastal erosion problem is not solved.

I believe that the New Orleans District, Corps of Engineers, is aware that the present method of determining the beneficial aspects of marsh and barrier island protection does not adequately address the situation that exists in Louisiana. The current system of determining the value of our marshes is very narrow, giving dollar values for our marsh as real estate, and as a producer of commercial and recreational fish and wildlife but very little more. It does not take into account what you in your Land Loss and Marsh Creation study call "intangibles". The "intangibles" in this case may turn out to be life as we know it in south Louisiana.

Unlike most other states which have only small amounts of uninhabitable wetlands, Louisiana has millions of acres of wetlands, 41 percent of all the wetlands in the lower 48 states, and our coastal zone is inhabited by over 2 million people. The Land Loss and marsh Creation study states, and I quote:

> "Land loss seriously threatens the very vitality of the coastal area and its capacity to support the multi-use functions important to the state and the nation."

It further states that if nothing is done to stop erosion, not only will the state and the nation suffer a tremendous loss of commercial and recreational fisheries, but by the year 2040, 155 miles of waterways will be lost to open water and will require increased maintenance dredging; 55 miles of federal hurricane protection projects that protect New Orleans and other coastal communities will have to be shielded from erosion and enlarged to

maintain their current level of protection; 94 miles of federal and state highways, 27 miles of railroad track, 1,570 miles of oil and gas pipeline and 333 miles of gas, water, electric power and telephone lines will have to be relocated.

It goes on to state that in addition to this:

> "About 1,800 businesses, residences, camps, schools, storage tanks, electric power substations, water control structures, and pumping stations for gas, oil, and water will have to be protected or relocated."

These are just some of the "intangibles" which were not considered in the evaluations of the proposed projects in the Land Loss and Marsh Creation and the Shore and Barrier Island Erosion Studies. These factors must be considered in any system that places a value on our wetlands in order to determine the real benefits of these projects. Why can't protection of these things be included on the benefit side of the benefit/cost ratio? Let's look at Project on Page 7 of the Shore and Barrier Island Erosion study. The study estimated that between 1979 and 1981 that 170,000 people visited the Fort annually. It goes on to say that "the Fort will soon be undermined if erosion is not checked." Yet, the benefit value for creating a breakwater to save the fort is placed at $400 a year. The Corps' reasoning for this is that less than an acre of marsh will be saved by this breakwater project per year. The average value of Louisiana marsh is $1,500 per acre. Therefore, the value of building the breakwater is only about $400 a year. In other words, the value given to this project does not take into account the possible loss of Fort Pike or the social and monetary value of the 170,000 annual visitors to the historic fort. It merely estimates the value of the amount of marsh lost per year.

The Terrebonne Parish Barrier Islands project on Page 9 is another good example where the present benefit accounting system does not fully assess the benefits of the project. The study discussing the Timbalier and Isles Dernieres Island chain, states:

> "If the present situation continues, most of the Terrebonne islands will be gone by 2040. Once they are lost, Terrebonne Parish will become completely vulnerable to storm attacks and the nation will lose the important resources of the islands."

But, again the benefit accounting system only accounts for the value of the marsh loss showing an annual average benefit of $1,108,500 and a benefit/cost ratio of 0.9 to 1. The benefit accounting system does not seem to account for the hundreds of homes and camps and the infrastructure for them that will become vulnerable to storms if these barrier islands are lost. This project would certainly have a favorable benefit/cost ratio if all the real benefits of the project were included.

The present system of analyzing marsh benefits may be fine for other areas of our country with small amounts of uninhabited wetlands, but it does not give a realistic value to marsh building or erosion prevention projects in Louisiana. Furthermore, all the benefit/cost ratios of the Land Loss and Marsh Creation and the Shore and Barrier Island Erosion projects are grossly underestimated. A new system for evaluating the value of wetland erosion prevention and marsh creation projects needs to be developed which takes into account the coastal conditions of Louisiana.

The two studies, Louisiana Land Loss and Marsh Creation and Louisiana Shore and Barrier Island Erosion, seem to be so inter-

related that they should be considered as one. Why not combine these two into one study, devise a conglomerate solution, and determine one benefit/cost ratio for the entire conglomerate?

I would now like to comment of the Coastal Water Supply Initial Evaluation Study.

The State of Louisiana through the Water Resources Study Commission staffed by the Department of Transportation and Development, Office of Public Works, has just completed a comprehensive review of the water situation in the State. In addition to the Water Resources Study Commission's report, the Office of Public Works has prepared an in-house document on alternative solutions to water supply problems. In that report, we have looked at the same problem areas in coastal Louisiana as did the Corps.

I will discuss each one comparing the results.

Grand Isle

We both agree on the amount of additional water required by Grand Isle and that a desalination plant for treating brackish groundwater is the best alternative (Your Plan 3). The desalination plan is good because it provides a reliable year round source of water for Grand Isle on Grand Isle. It does not rely upon a water treatment system in a neighboring parish with its accompanying long pipe lines to Grand Isle. It also does not rely upon barges to ship freshwater in which could create a logistics headache for scheduling, not to mention sanitation problems. We feel, therefore, that the other plans do not compare favorably with the desalination of brackish groundwater.

A lot of ground work has already been done on a possible desalination plant for Grand isle which was prepared for the U.S. Department of Interior, Office of Water Research and Technology. From this information, the Office of Water Research and Technology chose Grand Isle for a desalination demonstration project. Unfortunately, this project was cancelled before construction. Possibly this information would be beneficial to the you in your further study.

Houma

The Office of Public Works' projections for public supply water requirements in Terrebonne Parish for the year 2020 indicate a need for 22 million gallons per day. Since Houma's public supply system provides water not only to the City of Houma but also provides all the water to Terrebonne Parish Water Districts 2 and 3 and some water to Water District No. 1 we, therefore, believe that Houma's needs listed by the Corps for the year 2020 of 12 million gallons a day may be low.

We are in agreement with the alternative of using Bayou Lafourche as a source of freshwater (Plan 7). Even though Bayou Lafourche is in another parish, Houma would only be relying on it for a source of raw water continuing to use their existing treatment plant. This alternative is presented as an emergency 50 day supply during periods of saltwater intrusion into the Gulf Intracoastal Water Way; but there really is no reason why this could not become Houma's permanent source of supply, if that becomes necessary or desirable.

The reservoir storage plan (Plan 9) we suspect would not be adequate if, in fact, 22 million gallons a day were needed by the year 2020, because the dependable yield of the reservoir could not meet the demand.

Plaquemines Parish

Open reservoirs appear to be the best alternative using the benefit/cost ratio. You state that "some marsh may be lost in construction of the reservoir," but that "the environmental impacts are not severe." Our concern is the benefit/cost ratio may not be adequate for the determination of the benefits of marsh land as we have mentioned earlier. Therefore, we feel that the 3.3 benefit/cost ratio may be artificially high and misleading. A new system for determining the value of marsh land is needed. However, we do agree that this plan looks promising and merits further study.

The River Parishes

You are recommending reservoirs which may have associated environmental problems. Even so, we believe the alternative should be studied further.

An additional alternative merits investigation, that is, groundwater below Lake Pontchartrain. The color of the groundwater is not ideal, but the quality meets the standards.

Cameron-Holly Beach

The community of Holly Beach through the creation of Cameron Water Works District No. 10 has recently started purchasing groundwater from Cameron Water Works District No. 2 in Hackberry which is what you recommended in Plan 22.

We are in agreement that Cameron has a problem with high chlorides in their water supply and with your alternative Plan 22, "Import groundwater from a more northerly site." We, however, would recommend a well field site east of Calcasieu Lake and north of Creole rather than at Hackberry.

Importing water from the Intracoastal Waterway, Plan 20, shows promise but would require treatment. Desalination of brackish groundwater, Plan 21, we believe would also merit additional study. The benefit/cost ratio should improve with a smaller desalination plant now that Holly Beach has solved its problem.

Mermentau River Basin

A feasibility study on the management of the Grand and White Lakes Complex is being done by the U.S. Army, Corps of Engineers. Since the Mermentau River is supplemented by water from the Grand and White Lake Complex, the two studies should be integrated no mater which alternatives are chosen.

Plan 26, storage north of GIWW indicates the highest benefit/ cost ratio. However, again let me point out that the B/C ratio may be misleading and should be reevaluated when a new system for adequately determining the benefits of marsh land is established.

I would like to thank the U.S. Army, Corps of Engineers, for giving us this opportunity to comment on these three studies tonight. I hope that our comments will be of some help to you. You are welcome to any information we may have that will assist you in your further studies. We do wish to be kept apprised of your findings and wish to be part of the planning process as we think it is our assigned responsibility to do so.

STATEMENT OF LOUISIANA DEPARTMENT OF WILDLIFE AND FISHERIES

Presented at the public meetings held on August 27, 28, and 30, 1984, to discuss studies on Land Loss and Marsh Creation, Water Supply, and Shore and Barrier Island Erosion in the Louisiana coastal area.

Colonel Witherspoon, distinguished guests, ladies and gentlemen. My name is Chuck Killebrew of the Louisiana Department of Wildlife and Fisheries. I hope everyone here tonight will agree that we all have, in one way or another, a vested interest in the difficult problem that is now facing us. Simply stated, the problem is the continued deterioration and loss of our coastal region, including its wetlands, estuaries and barrier islands. We recognize that the situation is due, in large part, to the construction of the Mississippi River levee system which, severely restricted the processes of seasonal overbank flooding and distributary flow. These processes provided nutrient and sediment-rich fresh water that helped to build and maintain a great part of Louisiana's coastal marshes and wetlands in its geological past. The reduction in freshwater flow and the combined effects of subsidance and erosion and saltwater intrusion, which is sometimes accelerated by continuing canal and levee construction, have caused a conversion and destruction of thousands of acres of our coastal region in just a few short decades. The collection of information represented by the Louisiana Coastal Area Study could, in our opinion, serve a very useful purpose. The study provides an overview of these complex problems involving the decline in fish and wildlife production, deterioration of enviromental quality, and the social-economic consequences resulting from land loss in our coastal area, and delineates those areas that urgently need attention on a coast-wide basis. At the outer edges of Louisiana's coastal region, the barrier islands have historically served to protect the integrity of the mainland marshes and estuaries, particularlly during gulf storms and hurricanes. The shore and barrier island portion of the study mentioned eight areas, extending from the Chandeleur Islands on the east to Holly Beach area on the western Louisiana coast, that are rapidly eroding

and for which erosion stabilization measures are required. Various structural and nonstructural methods were evaluated including filling backbays and canals, revegetation with beach grasses and pioneer shrubs, the use of sand fencing and installation of breakwaters, all techniques that have been successfully applied in other coastal states. The Department of Wildlife and Fisheries supports the general program of barrier island protection, stabilization, and restoration, particularly as an aid in protecting the mainland marshes, their productivity, and associated recreational and commercial economies. Over the past few years, various alternatives have been considered in an effort to reduce losses to marshlands or to enhance marsh production in the coastal areas. These included marsh creation by the use of dredge material deposition, stricter regulation of canal dredging including canal backfilling or blockage, maximizing delta development at the mouth of the Atchafalaya River and fresh water diversions from the Mississippi River. All these measures have considerable merit and we encourage their application as appropriate to conditions and circumstances. We, nevertheless, believe that among all measures considered, the most effective means now available to us to achieve salinity conditions favorable to fish and wildlife production, reduce or reverse marsh loss rates, and to halt the general degredation in the quality and extent of our coastal area is by the large scale introduction of sediment-laden fresh water from the Mississippi River. We encourge the Corps to continue studies of this alternative. The department certainly recognizes that one serious problem associated with coastal erosion and subsidence is saltwater intrusion into the fresh water sources used by the coastal communities. The initial water supply study evaluated some 27 alterative proposals coast-wide that could alleviate this problem and help ensure an adequate amount of fresh water during the periods when the normal supplies are threatened. We note that 2 of these proposals, however, designated as Plans 13 and 14, would envolve construction of freshwater reservoirs at 2 sites: one at Davis Pond on the west bank of the Mississippi River near the department-owned Salvador Wildlife Management Area, and the other at Big Mar on the east bank of the river. Both of these sites are currently under study for the location of

freshwater diversion structures. While the department clearly recognizes the need to ensure an adequate supply of fresh water to our coastal communities, we feel it is important to emphasize that the proposed freshwater diversion projects would be designed for the purpose of protecting and enhancing fish and wildlife habitats and resources and the economies dependent on those resources. It is our position that Plans 13 and 14 could seriously jeopardize the success of these greatly needed freshwater diversion projects by causing lengthy delays in project planning and development. The delays could possibly affect the outcome of congressional authorization and funding decisions. The successful operation of the diversion structures could also be jeopardized by establishing conflicting purposes and management goals. In addition, the establishment of freshwater reservoirs in the proposed overflow areas require sacrificing large areas of productive marshes. We recognize that the coastal area study conclusions are preliminary and tentative at this stage and are only suggestive of the possible courses of action. However, we wish to make very clear early in this study our strong opposition to Plans 13 and 14 for the reasons cited above and to encourage the evaluation of other measures, particularly for the river parishes water supply. Finally, we believe the coastal area study could lead to an intensification of Federal, state, and local effort and participation to reduce saltwater intrusion and land loss from all causes across the state's coastal area, and the department, therefore, encourages its progress.

JEFFERSON PARISH

LOUISIANA

OFFICE OF PARISH PRESIDENT

JOSEPH S. YENNI
PARISH PRESIDENT

September 14, 1984

Lt. Col. Edward J. Willis
U.S. Army
Corps of Engineers
P.O. Box 60267
New Orleans, LA 70160

Re: B&A Job No. 8427-99

Dear Lt. Col. Willis:

Let us first congratulate the Corps for taking the initiative to hold public hearings regarding such serious issues as land loss, erosion and water supply problems in the state of Louisiana.

As you are aware, in Jefferson Parish, the sole source of drinking water supply is the Mississippi River. It's an open and navigable water body prone to toxic spills and thus, there is the possibility of contaminating the drinking water supply. The other problem with the present system is the lack of storage capacity for emergency purposes. These two problems underscore the need to evaluate alternate sources of drinking water supply and the storage facility for emergency purposes.

Based on the literature search done by the Parish's consultants, Burk and Associates, Inc., it is clear that there are three main fresh water aquifers in the region, namely 200-foot, 400-foot and 700-foot sand. Most of the ground water supply of current users, largely private, comes out of these aquifers and so they are limited in their potential for emergency supply requirements of the Parish. On the other hand, ground water is one of the main alternates to consider because it does not have the instant contamination potential like the river water does. Therefore, it is relatively safe.

There is freshwater aquifer in the northern as well as the western parts of Lake Pontchartrain. An exploratory study, done by the USGS in Orleans Parish's part of the Lake, showed the existence of freshwater aquifers. However, nothing along these lines has ever been done in Jefferson Parish's part of the Lake.

Until some time ago, it was not known to us what might be the extent of aquifers in the southern parts of Lake Pontchartrain. In the absence of any exploratory borings, the information on the availability of water was arrived at by evaluating the existing electrical logs for oil and gas wells. The logs were provided by the Department of Conservation and Resources, Baton Rouge.

SUITE 402 3330 N CAUSEWAY BOULEVARD, P.O BOX 8550, METAIRIE, LOUISIANA 70011, 504-834-7700

At the Coprs of Engineers' Public Hearing in Belle Chasse, three topics were considered to be the theme of the Hearing: (1) water supply, (2) land loss and (3) erosion. Not much was said about drinking water problems. The present water supply is dependent upon the characteristic fluctuations of the Mississippi River water. A phenol spill in early 1981 made the tap water undesirable for drinking for several days and there was no alternate supply or adequate storage reservoir to switch over to. If anything massive ever occurs, there will not be an alternate source of water supply to rely on. This makes it more urgent and important to look for a pragmatic solution to this problem.

Looking towards the ground water as the ptential source seems to be the way to solve this problem.

Existing ground water aquifers in Jefferson Parish could be evaluated in terms of storing treated Mississippi River water to be pumped out in case of an emergency, or exploration could be done to evaluate the existing aquifers in the southern part of Lake Pontchartrain in Jefferson Parish.

Existing aquifers in the Lake may very well have the potential for solving our problems along with a fresh water reservoir of capacity to provide for no less than a 15 day emergency. Therefore, it is our request that the Corps consider these as viable alternatives in solving the drinking water problem and include these two options to be a part of Phase II of the study, which is the "Feasibility Study" of the alternatives.

For your information, we are attaching a copy of Resolution No. 50994 of the Jefferson Parish Council meeting of June 6, 1984, which indicates the serious concern of the Council in this water supply problem and calls upon the congressional delegation for their help.

Very truly yours,

JOSEPH S. YENNI
PRESIDENT

On motion of Mr. Ward, seconded by Mr. Hof, the following resolution was offered as amended:

RESOLUTION NO. 50994

A resolution requesting Senators J. Bennett Johnston and Russell Long and Congresspersons Lindy Boggs, Billy Tauzin, and Bob Livingston to give assistance to Jefferson Parish to locate and obtain federal funding assistance for planning and improvements to its overburdened water system, and authorizing the Council Chairman, or in his absence, the Vice-Chairman to execute a contract with Burk and Associates, Inc., for professional engineering services and assistance in obtaining said federal funding assistance and to further execute a contract with Burk and Associates, Inc.. for professional engineering services in connection with those projects, particularly, needed water plant expansions, that are funded in whole or in part by the efforts of Burk and Associates, inc., and our congressional delegation in obtaining federal funding assistance for said projects.

WHEREAS, the Parish of Jefferson has experienced tremendous residential, commercial, and industrial growth since the capacity of the existing water plants were last increased; and,

WHEREAS, at this time the ability of the Parish of Jefferson to make and supply water to its customers is rapidly becoming inadequate to meet demands; and,

WHEREAS, it is necessary that the parish request funding assistance from its congressional delegation to address the needs of its overburdened water system; and,

WHEREAS, the engineering firm of Burk and Associates, Inc., in conjunction with the Parish of Jefferson Federal Liaison Department, has successfully assisted the parish in the past in the area of securing funds, as well as in design of facilities.

NOW, THEREFORE, BE IT RESOLVED by the Jefferson Parish Council, acting as the governing authority of said parish:

SECTION 1. That Senators J. Bennett Johnston and Russell Long and Congresspersons Lindy Boggs, Billy Tauzin, and Bob Livingston are hereby requested to give assistance to the Parish of Jefferson to locate and obtain federal funding assistance for planning and improvements to its overburdened water system.

SECTION 2. That the Council Chairman, or in his absence, the Vice-Chairman, be and is hereby authorized and empowered to execute a contract with Burk and Associates, Inc., for professional engineering services in assisting the Jefferson Parish Congressional Delegation and the Parish of Jefferson Federal Liaison Deparment in locating and obtaining federal funding assistance for planning and improvements to Jefferson Parish's overburdened water system for a period not to exceed two (2) years.

SECTION 3. That the Council Chairman, or in his absence the Vice-Chairman, be and is hereby authorized and empowered to execute a contract with Burk and Associates, Inc., for professional engineering services in the planning, design, and construction of those projects, including east and west bank water plant expansions, that are funded in whole or in part with the federal funds obtained through the efforts of Burk and Associates, Inc., and the Jefferson Parish Congressional Delegation, for a period not to exceed two (2) years.

The foregoing resolution having been submitted to a vote, the vote thereon was as follows:

YEAS: 7 NAYS: None ABSENT: None

The resolution was declared to be adopted on this the 6th day of June, 1984.

THE FOREGOING IS CERTIFIED TO BE A TRUE AND CORRECT COPY

Dolores H. Gonzales

DOLORES H. GONZALES
PARISH CLERK
JEFFERSON PARISH COUNCIL

GENTLEMEN:

MY NAME IS STUART GUEY AND I AM A MEMEBER OF THE PLAQUEMINES PARISH COMMISSION COUNCIL REPRESENTING THE BELLE CHASSE AREA. TONIGHT WE ARE ASKED TO COMMENT ON THREE AREAS WHICH THE U.S. ARMY CORPS OF ENGINEERS HAS PERFORMED AN INITIAL EVALUATION STUDY. THE THREE AREAS, HOWEVER, COULD BE COMBINED FOR THEY ALL RELATE SO CLOSELY TO ONE ANOTHER. EACH OF THESE PROJECTS ARE VITAL TO THE WELL-BEING AND FUTURE TO THE PEOPLE OF PLAQUEMINES PARISH WHO EARN THEIR LIVING EITHER DIRECTLY OR INDIRECTLY FROM TWO SPECIFIC AREAS.

THE FIRST AREA BEING THAT OF THE VAST RENEWABLE RESOURCE BASE WE HAVE IN PLAQUEMINES PARISH and THE PEOPLE WHO USE THE MARSH SYSTEM AS THEIR SOURCE OF INCOME. AND SECOND, THE PEOPLE WHO RELY ON THE OIL AND GAS INDUSTRY FOR THEIR LIVELIHOOD. THE FUTURE OF BOTH GROUPS RELIES ON EXACTLY WHAT WE'RE DISCUSSING TONIGHT, THE FIRST GROUP BY THE RESOURCES PROVIDED FROM THE MARSHLANDS AND BOTH GROUPS BY THE INVALUABLE AMOUNT OF HURRICANE AND STORM SURGE PROTECTION AFFORDED TO [redacted] HOMES AND BUSINESSES BY THE MARSH SYSTEM.

THEREFORE, IT IS VITAL THAT YOU, THE CORPS THOROUGHLY ASSIMILATE ANY AND ALL INFORMATION POSSIBLE, NOT ONLY AT PUBLIC HEARINGS BUT THROUGH THE INPUT OF THE MANY USER GROUPS WE HAVE HERE IN PLAQUEMINES PARISH. YOUR SUCCESSES WILL INCREASE AND ANY RESISTANCE YOU MAY [redacted] WILL BE DECREASED DUE TO THE INVOLVEMENT [redacted] EDUCATION OF THOSE PEOPLE MOST AFFECTED BY THESE PROJECTS. I MUST RELATE TO YOU THE SITUATION AT CAERNARVON. YOU HAVE DONE AN OUTSTANDING JOB IN MANY ASPECTS OF THIS PROJECT BUT IT SEEMS YOU MISSED THE BOAT ON ONE POINT. THAT POINT BEING THE ABSENCE OF THESE USER GROUPS DURING MANY OF THE PAST PRELIMINARY AND PRESENT INTERMEDIATE PLANNING SESSIONS. MAYBE YOUR POLICY DICTATES THAT PUBLIC INVOLVEMENT BE ONLY FROM PUBLIC HEARING - IF THAT IS THE CASE SOMEONE SHOULD CHANGE THE POLICY. AS EARLY IN THE GAME AS POSSIBLE, IT

imperative
IS ~~THAT~~ THAT YOU RECEIVE THE MAXIMUM AMOUNT OF INPUT FROM THOSE PEOPLE
most
WHO ARE DIRECTLY IMPACTED AND I HOPE THAT YOU CONSIDER A METHOD OF IN-
these projects
VOLVING THE PEOPLE OF PLAQUEMINES PARISH THOUGHOUT ~~THE~~ PROJECTS.

ANOTHER POINT WHICH MUST BE ADDRESSED:

YOU MENTION THAT DURING THE COURSE OF YOUR STUDY ~~THERE~~ YOU HAVE FOUND
EXTREMELY
THERE TO BE A LACK OF AVAILABLE INFORMATION. I FIND THIS ~~VERY~~ HARD TO BE-
LIEVE. IN A LETTER TO COLONEL ROBERT LEE ON OCTOBER 19, 1983, COMMISSIONER
MICHAEL KIRBY AND I OFFERED ANY ASSISTANCE POSSIBLE IN THE WAY OF PROVIDING
DATA. THE PURPOSE OF THIS WAS TO ELIMINATE, AS MUCH AS POSSIBLE, ANY DUPLI-
CATION OF EFFORTS. LATER I WAS ADVISED BY TELEPHONE THAT THE CORPS HAD
OBTAINED MOST OF THE INFORMATION WHICH HAD BEEN PUBLICLY DOCUMENTED AND WAS
SEARCHING FOR ANY ADDITIONAL DATA WHICH MAY HAVE BEEN MISSED. I HOPE THAT
IT IS NOT THE POSITION OF THE CORPS TO USE ~~THE~~ EXISTING DATA ONLY TO FORM A
BASIS FOR ANOTHER TIME-CONSUMING CORPS-ORIENTED STUDY. AGAIN, I RELATE TO
CAERNARVON. AT PRESENT I HAVE BEEN INFORMED THAT THE CORPS IS GOING TO SET
UP A PRE-CONSTUCTION AND POST-CONSTRUCTION MONITORING PROGRAM FOR THE CAER-
NARVON PROJECT. IN SPITE OF THE FACT THAT THE PLAQUEMINES PARISH COMMISSION
COUNCIL HAS HAD A MONITORING PROGRAM IN EFFECT IN THIS AREA FOR MANY YEARS
AND PRESENTLY HAS AN OUTFALL MANAGEMENT PLAN WITH DATA WHICH COULD BE VERY
I'm sure that by utilizing what Plq. Parish has to offer
USEFUL AND SAVE TIME. I HOPE MY POINT IS WELL TAKEN THAT ADDITIONAL TIME
CONSUMING STUDIES MAY BE UNWARRANTED, FOR THERE ARE VOLUMES AND VOLUMES OF
DATA AVAILABLE WHICH WILL DEFINITELY AID IN SPEEDING UP THIS PROCESS.

* that the 1.3 million cost of your monitoring progrm could be significantly reduced!.

ANOTHER ISSUE WHICH WILL AID TREMENDOUSLY IN VALIDATING ANY OF THESE
PROPOSALS BY INCREASING THE ECONOMIC BENEFIT AFFORDED, THIS BEING "THE TRUE
VALUE OF THE MARSH." BY YOUR OWN STATEMENT YOU ADMIT THAT THIS VALUE HAS
NOT YET BEEN DETERMINED. LET ME TELL YOU, WHEN YOU ACTUALLY TAKE INTO CON-
SIDERATION THE ADVERSE IMPACT A DETERIORATED MARSH WILL HAVE ON OUR RENEWABLE
+mineral
RESOURCE BASE, THE OIL ~~AND~~ GAS INDUSTRY, THE LIVEABLE LAND AREA, RECREATIONAL

ACTIVITY, AND THE AMOUNT OF HURRICAN PROTECTION AFFORDED, YOU WILL FIND THE VALUE OF AN ACRE OF MARSH TO SKYROCKET AND THE ECONOMIC FEASIBILITY OF THESE PROJECTS to BECOME MORE FAVORABLE. PLEASE ALSO REALIZE THE RIPPLE EFFECT WE'RE DISCUSSING HERE! THE LOSS OF INCOME, NOT ONLY TO PLAQUEMINES PARISH BUT IN TURN TO THE STATE OF LOUISIANA AND EVENTUALLY THE NATION AS A WHOLE.

ALL OF THESE AREAS I HAVE JUST DISCUSSED WERE BROUGHT TO YOUR ATTENTION TO MAKE A SINGLE POINT. THAT POINT BEING TIME, WE DON'T HAVE MUCH TIME. CAERNARVON DISCUSSIONS BEGAN OVER 20 YEARS AGO AND CONSTRUCTION SHOULD BE COMPLETED SOME 26 YEARS FOLLOWING THOSE DISCUSSIONS. WE DON'T HAVE 26 YEARS. I IMPLORE YOU TO WORK CLOSELY WITH US HERE IN PLAQUEMINES PARISH FOR WE CAN AFFORD MANY SERVICES THROUGH NOT ONLY THE COMMISSION COUNCIL BUT THROUGH UNDOCUMENTED KNOWLEDGE OBTAINABLE THROUGH ACTIVE PUBLIC INVOLVEMENT AND PARTICIPATION WHICH WILL EXPEDITE MATTERS AND MAKE FOR A MORE SUCCESSFUL PROJECT.

BRIEFLY LET ME POINT OUT A FEW SPECIFICS ON EACH OF THESE AREAS:

1) MARSH CREATION

SPECIFICALLY PLEASE STUDY THE AREA OF THE JUMP IN VENICE. FROM MAPS I HAVE SEEN, at this vicinity WHICH GO BACK AS FAR AS 1894, THERE SEEMS TO HAVE BEEN A TURN-AROUND FROM A MARSH BUILDING AREA TO A MARSH DETERIORATING AREA SOMEWHERE IN THE LATE 1950'S. IT IS MY UNDERSTANDING THAT in the mid 50's A SILL WAS PLACED ACROSS THE JUMP AREA AT APPROXIMATELY -20 FEET FOR THE PURPOSE OF DIVERTING SEDIMENT DOWN THE RIVER. LOOK INTO THE FEASIBILITY OF REMOVING THIS OBSTRUCTION SO THAT THIS AREA MAY REVERT BACK TO THE WAY NATURE HAD THINGS PLANNED. BECAUSE OF THE PRESENT DETERIORATED CONDITIONS IN THIS AREA, THE OYSTER INDUSTRY HAS SUFFERED GREAT LOSSES DUE TO THE INFLUX OF TOO MUCH FRESHWATER DURING HIGH RIVER. PRIOR TO THE SILL CONSTRUCTION WHEN THIS AREA WAS STABLE, THE FRESHWATER MADE ITS WAY VIA TIGER PASS AND GRAND PASS TO THE GULF OF MEXICO. BECAUSE OF THE CHANGES OCCURRING TODAY OF FRESHWATER IMPACTING AND KILLING

SALTWATER MARSH, WE NO LONGER HAVE THE NATURAL SYSTEM of sedimentation WHICH ONCE PROTECTED THE AREAS BEHIND BURAS AND BOOTHVILLE FROM THIS EXCESS FRESH WATER. IT WOULD SEEM ALOT CHEAPED TO USE AN EXISTING AREA WITH MARSH BUILDING CAPABILITIES THAN TO BUILD A DIVERSION WITH A POSSIBLE COST OF 14-74 MILLION DOLLARS, DEPENDING ON THE SIZE, WHICH WOULDHAVE A USEFUL LIFE OF ONLY 15 YEARS.

AS TO WATER SUPPLY - PLANS OF POSSIBLY INCORPORATING THE DAVIS POND AND CAERNARVON STURCTURES TO BE USED AS A 15 DAY STORAGE RESERVOIR IN THE EVENT OF A HAZARDOUS WASTE SPILL MAKING ITS WAY DOWN THE RIVER SEEM VERY FEASIBLE. AS TO A RESERVOIR IN THE EAST POINT-A-LA-HACHE AND BOOTHVILLE AREAS, WHAT OF THE STATUS OF THE PROPOSED 55 FOOT CHANNEL DEEPENING of the Miss. River. MONIES WERE APPROPRIATED TO BUILD RESERVOIRS IN EAST AND WEST POINTE-A-LA-HACHE TO SERVE AS MITIGATION FOR THE EXCESS SALT WATER EXPECTED FROM THE RIVER DEEPENING. WE MUST investigate as to HOW THESE TWO PROPOSALS FOR RESERVOIR CONSTRUCTION INTERRELATE.

IN ESSENCE WE ARE BEING TOLD THAT ONE, "YOU IN PLAQUEMINES PARISH WILL BE IMPACTED BY THE RIVER-DEEPENING PROJECT AND SECOND THAT THE MISSISSIPPI RIVER WILL MORE THAN LIKELY BECOME MORE POLLUTED. That is unless E.P.A. DOES ITS JOB AND CLEANS UP THE WATER." IN BOTH INSTANCES THE TAX PAYERS OF PLAQUEMINES PARISH WILL HAVE TO PAY FROM IMPACTS RECEIVED BOTH UPSTREAM AND DOWNSTREAM.

ON THE ISSUE OF SHORELINE ANL BARRIER ISLAND PROTECTION, THERE IS A 25-MILE AREA FROM SANDY POINT TO 4-BAYOU PASS WHICH NEEDS IMMEDIATE ATTENTION AND WAS NOT ADDRESSED IN YOUR INITIAL EVALUATION STUDY. IF WE RANK AREAS IN THE ORDER OF THEIR BARRIER ISLAND AND SHORELINE DETERIORATION, YOU CAN LIST FIRST THE CHANDELIER ISLAND CHAIN, SECOND THE TIMBERLIER AND GRAND ISLAND AREA, AND THIRD THIS 25-MILE STRIP WHICH WAS MENTIONED ABOVE. IT WOULD SEEM RATHER THAN WAIT FOR THIS AREA IN PLAQUEMINES PARISH TO DETERIORATE TO THE EXTENT OF THE TWO OTHER ABOVE MENTIONED AREAS THAT IT WOULD BE LESS COSTLY TO ADDRESS THIS AREA NOW BEFORE WE ARE LEFT WITH ONLY A BARRIER ISLAND CHAIN TO CONTEND WITH.

ALL-IN-ALL LET ME SUM UP:

THROUGH THESE PROJECTS WE ARE HEADING IN THE RIGHT DIRECTION AND HOPEFULLY WE CAN RESTORE AN AREA WHICH HAS BECOME AS IT IS BECAUSE OF OUR UNIQUE ABILITY TO HARNESS NATURE. OF THE MILLIONS OF DOLLARS WE HAVE SPENT AND WILL CONTINUE TO SPEND TO CONTROL NATURE, WE HAVE TO BE COGNIZANT OF THE FACT THAT IT WILL TAKE ADDITIONAL MILLIONS OF DOLLARS IN THE WAY OF RESTORATION TO CORRECT WHAT WE HAVE DONE!

AND TO REITERATE, THERE IS AVAILABLE DATA WHICH MAY CURTAIL THE NEED FOR ANY EXTENSIVE ADDITIONAL TIME-CONSUMING STUDIES. MUCH OF THAT DATA HAS BEEN DOCUMENTED. AND MUCH, WHICH IS UNDOCUMENTED. THIS VALUABLE UNDOCUMENTED INFORMATION CAN BE FOUND HERE - IN THE HEART, SOULS, AND MINDS OF THE PEOPLE OF PLAQUEMINES PARISH - PROBABLY YOUR MOST IMPORTANT INFORMATION RESOURCE. USE IT!

PARISH COUNCIL

PARISH OF TERREBONNE
POST OFFICE BOX 2768
HOUMA, LOUISIANA 70361
(504) 868-3000

September 07, 1984

Colonel Eugene S. Witherspoon, District Engineer
U.S. Army Corps of Engineers
New Orleans District
P.O. Box 60267
New Orleans, Louisiana 70160

RE: Public Hearing Comments
Louisiana Area Studies
Initial Evaluation

Dear Colonel Witherspoon:

The Terrebonne Parish Council would like to take this opportunity to welcome you to South Louisiana and the nation's largest wetland consisting of 6.5 million acres. As you may already know however, these wetlands are out of balance.

Terrebonne Parish, which comprises over 10% of these wetlands, is washing away into the waters of the Gulf of Mexico. This land has always been battered, broken up and swept away by the gulf, but in ages past it was balanced by the build-up of land created by the flow of seasonal flooding of the Mississippi River and its associated bayous. Today, artifical levees and flood control projects have stopped Mississippi River flooding and the associated build-up of new land. Other man-made activities such as canalization and oil and gas exploration, have contributed to the problem. Compounding these problems are the natural processes of land subsidence and sea level rise. All of these problems have contributed to land loss figures which exceed 17 acres a day within the boundaries of Terrebonne Parish.

The man-made elements that have altered flow regime sediment patterns and vegetative assemblages have created a problem. Land loss forces now supersede constructive forces, thus threatening the jobs, industries, and life-styles of the people whose lives are tied directly or indirectly to the coast. The final question is, "Can we afford the loss?". We, of Terrebonne Parish feel the only answer to this question can be NO! We hope that the federal government, and particularly the Corps of Engineers, feel the same and will support Terrebonne's efforts to preserve and maintain its unique and valuable wetland.

Attached for your review and information is a copy of Terrebonne Parish's "Barrier Island and Marsh Management Program; Executive Summary". Within this summary, we document Terrebonne's land loss problem and the solutions which the Parish will undertake in order to correct these problems.

Also attached for your review and information is a copy of a resolution which summarizes our comments to Colonel Willis in reference to the public hearing that was held on August 28th concerning to the three Louisiana area initial evaluation studies. This resolution, along with the Executive Summary, constitutes Terrebonne's comments at the public hearing.

We encourage that the Corp continue to work and support the efforts of local governments, and that the Corp study our findings and our plans and proceed accordingly to work jointly with state and local governments in solving the problem which faces Terrebonne Parish and the surrounding wetlands.

If we can be of any assistance to you in the future, or can provide any information to you, please do not hesitate to call.

Sincerely,

J. D. Boudreaux III

J.D. Boudreaux, III
Chairman, Terrebonne Parish Council
TERREBONNE PARISH CONSOLIDATED GOVERNMENT

JDB/JBE/wtm

Enclosure

cc: Colonel Willis, U.S. Army Corp of Engineers

TERREBONNE PARISH

BARRIER ISLAND AND MARSH MANAGEMENT

PROGRAM

EXECUTIVE SUMMARY

Prepared By:

TERREBONNE PARISH GOVERNMENT

James B. Edmonson
Robert S. Jones

July, 1984

TABLE OF CONTENTS

TITLE

I. INTRODUCTION AND IDENTIFICATION OF PROBLEM

Terrebonne is washing away into the waters of the Gulf of Mexico. This land has always been battered, broken up and swept away by the Gulf--but in ages past, it was balanced by the build-up of land created by the flow and seasonal flooding of the Mississippi River and its associated bayous. Today, artificial levees and flood control projects have stopped Mississippi River flooding and the associated build-up of new land. Other man-made activities, such as canalization, oil and gas exploration, have contributed to the problem. Without the natural build-up of new land by the Mississippi River the effects of wind, waves, currents and tides increase. (Davis, 1983).

These disruptions in the natural cycles of Louisiana's deltaic plain have produced extreme land loss problems for Terrebonne Parish caused primarily by subsidence, erosion and sea level rise.

Over a twenty-three (23) year period from 1955-1978, it was documented that Terrebonne Parish lost fifteen (15%) percent of its land area and forty-two (42%) percent of its barrier islands. (Wicker et al, 1980). At these rates of erosion and those calculated for the main land, all of Terrebonne's erodable land will be gone in 98 years.

To explain the cause of these problems, the Parish developed the following slide show which has been prepared as part of Terrebonne's public relations

program. Over the past two years, the presentation you are about to see has been viewed by thousands, along with an accompanying show at civic club meetings, trade shows and in classrooms. Most recently these presentations have been viewed by coastal scientist and federal staff.

SLIDE SHOW

Terrebonne Parish: The Land, The People, and The Sea

II. PROGRAM GOALS

After identifying its problems, Terrebonne Parish developed goals to address the identified problems. These goals are:

1. To develop additional facts about the barrier islands and our marshes.

2. To draw public attention to and educate them on the problems associated with barrier island and marsh deterioration.

3. To develop and implement programs and plans for the preservation and protection of Terrebonne's multi-million dollar estuary.

4. To reduce the scope of damage to the barrier islands through physical change.

A. TO DEVELOP A COMPREHENSIVE DATA BASE

In the mid to late 1970's, the Parish recognized there was very little information on the subject of shore erosion, subsidence, marsh preservation and restoration of the barrier islands. We realized that to develop an effective program to address our problems it would be necessary to generate such information.

Therefore, from 1978 through 1981, the parish contracted professional assistance to prepare a habitat evaluation of the parish, two (2) barrier island restoration plans, an investigation into the use of dredged materials and a Coastal Zone Management Program document. However, as the Parish learned more about its condition, it became apparent that much more information would be required to solve our precarious situation. In the past several years, the Parish has undertaken or is planning the following programs or studies to develop additional facts about its barrier islands and marshes.

1) Sand Resource Inventory - The gulf bottom around our coastline is being investigated to locate sand resources. This investigation concentrates on identifying sand deposits on the shoreface and inner shelf that are suitable as a source for beach nourishment and dune construction material.

This study is presently being performed by Louisiana State University and the Louisiana Geological Survey under contract to Terrebonne Parish at a cost of $18,000.00. Preliminary results are in and the study will be completed by this fall.

2) Marsh Valuation Study - A marsh valuation study is being conducted to develop economic valuations of Terrebonne Parish wetlands, incorporating traditional and non-traditional values. This will assist the Parish Government in planning coastal protection strategies and will be used as an input into the U.S. Army Corps of Engineers present marsh value studies. Marsh values will indicate federal funding participation in restoration and hurricane protection projects.

This study is presently being performed through the Louisiana Universities Marine Consortium by Louisiana State University and Nicholls State University and is funded by Terrebonne Parish at a cost of $40,000.00.

3) Oyster Contamination Study - An Oyster Contamination Study has been intiated by Terrebonne Parish. This study deals primarily with the question of the sources of sewerage or fecal contamination and the methods used by health authorities in monitoring for fecal contamination. The sources of contamination, harvesting and market alternatives are being investigated.

This study has been funded by the Terrebonne Parish Government and the State of Louisiana at a cost of $80,000.00 and is being performed by the Louisiana Universities Marine Consortium, the Louisiana Department of Health and Human Resources and Nicholls State University.

4) Subsidence Study - A Subsidence Study has been initiated by the Parish. This two (2) year study will classify the marsh and ridge lands as either stable, erosionable or accretional. With this knowledge, the Parish can prioritize and concentrate its management of the marshes and development accordingly.

This study will forecast net subsidence rates, taking into account sea level rise throughout the Parish for 5, 10, 15, 25 and 50 years.

This study has been funded by the Terrebonne Parish Government in the amount of $65,000.00 and is being performed by Louisiana State University and the Louisiana Geological Survey.

5) Ownership Study - A study to identify the ownership of the barrier islands was conducted by the Louisiana State University, Center for Wetland Resources for the amount of $30,000.00.

6) Soil Survey - To update the outdated soil survey for the parish, Terrebonne is proposing a new soil study to aid in determining the health and vitality of the wetlands. This project as proposed will be conducted by the U.S. Soil Conservation Service at a cost to the Parish of $300,000.00.

7) Sea Level Rise Study - To assist the Parish in analyzing and interpreting sea level rise data, the U.S. Environmental Protection Agency is funding a $10,000.00 drainage policy analysis contract.

In the future, Terrebonne intends to closely monitor and study Terrebonne's condition and all barrier island and marsh restoration projects in order to develop needed information on the true cost and effectiveness of such projects.

The following lists the people and organizations instrumental in developing the information obtained to help solve Terrebonne's problems of erosion and subsidence. Close contact and cooperation will have to be maintained between these people in order to effectively solve Terrebonne's problems.

Louisiana Center for Wetland Resources

Louisiana Geological Survey

Louisiana State University

Louisiana Universities Marine Consortium

Nicholls State University

Coastal Environments, Inc.

U.S. Soil Conservation Service

Louisiana Department of Health and Human Resources

Louisiana Department of Natural Resources

U.S. Environmental Protection Agency

U.S. Army Corps of Engineers, New Orleans District Office

Terrebonne Parish Government

B. TO EDUCATE THE PUBLIC

Last year, Terrebonne Parish recognized any effort to combat problems of such magnitude as coastal erosion, land subsidence and sea level rise was going to be long term and expensive. In order to maintain such an effort, the Parish realized that it needed full public cooperation and support.

In an effort to generate such cooperation and support, the Parish has embarked on a major educational program consisting of:

1) Slide Presentations - Recently, the Police Jury developed two (2) slide shows on the Parish's economy and the environment. One of these is the one you saw today. These shows have been so well received that congressional offices have inquired into the purchasing of copies.

2) Handouts - To supplement the slide shows, three (3) brochures were developed for distribution to the general public and the public school system.

3) Billboards - Posters have been designed to convey the importance of preserving our Barrier Islands and marshes. Two of these posters have been displayed on Houma area billboards.

4) Barrier Island Foundation - A foundation has been organized to encourage and support the continuation of efforts to protect and preserve the parish and its inhabitants.

5) School Programs - Most recently, the Parish Government in cooperation with Parish School Board, has developed and implemented an eighth grade curriculum dealing with the subjects of geology, the environment, utilization of renewable and non-renewable resources, erosional problems and solutions. It is hoped by educating our youth, they will grow and live within the Parish with a new sense of values for their environment and its productive potential.

It is hoped they will pass this on to their children. It is also realized the first 8th graders educated will be of voting age in ten (10) years and may be instrumental in supporting a parish tax for preservation purposes.

People and organizations who have been instrumental in developing these programs and with whom coordination must be maintained are:

Nicholls State University

Terrebonne Parish School Board

Coastal Environments, Inc.

LAMAR Billboards, Inc.

Donald W. Davis

Star Printing, Inc.

Terrebonne Parish Government

C. TO PRESERVE THE WETLANDS

Terrebonne Parish has recognized that its wetlands have immense monetary and esthetic value. Presently, Terrebonne's estuary produces over $30 million per year in seafood and recreational income. The Parish is unwilling to abandon its wetlands to the forces of nature. The Parish recognizes that stabilization and preservation of its barrier islands is just the beginning of the effort to save its wetlands. Therefore, plans and programs are now being generated and/ or implemented by both the public and private sectors in an effort to save Terrebonne's wetlands. Some of these programs and projects are:

1. Lake Boudreaux-wave stilling device utilizing old tires
2. Lake Penchant Management Study
3. Louisiana Wildlife & Fishery Montegue Marsh Management Project
4. Jug Lake-shoreline plantings of smooth cord grass
5. Numerous Oil Canals-shoreline plantings of giant cut grass
6. North Falgout Canal Area-3 or 4 fixed crest weirs and 2-10 foot flap gate weirs
7. Barrier Island fertilization projects and soil surveys
8. Mitigation Banking Programs
9. Fresh Water Diversion Plan
10. Parishwide Drainage Plan
11. Hurricane Protection Plan
12. Lower Sarah Forced Drainage Project
13. Coastal Eco-System Management Plan
14. Coastal Use Management Program

D. TO PRESERVE THE BARRIER ISLANDS

Terrebonne's barrier islands are its first line of defense against attack from the sea. If these islands are lost it is predicted that Terrebonne's land loss would accelerate geometrically. The Parish, therefore, has recognized its barrier islands are going to have to be stabilized and preserved if any effort at combating shore erosion and land subsidence is going to be successful.

The state of deterioration which characterizes the barrier islands of Terrebonne Parish, and Isle Dernieres in particular, results from wave action, subsidence, and increasing sand deficiency. Specific erosion rates for the Isles Dernieres chain over a twenty-three (23) year period show this barrier chain lost thirty-three (33%) percent of its total land area; eight (8%) percent of its beach area; forty (40%) percent of its marsh/mangrove habitants and sixty-four (64%) percent of its flats. Shoreline erosion rates averaged thirty-four (34) feet per year (Myer-Arendt and Wicker, 1982).

Much of the shoreline erosion can be attributed to subsidence factors, which include sea level rise, geologic downwarping and compaction due to weight. Isles Dernieres is also experiencing a high sand attrition rate. Islands breached during storms remain fragmentated, and major passes are developed between islands. These breaches, in turn disrupt the transport system of sand and decrease the sediment supply by acting as sediment sinks. The net result of this disruption of sand supply is increased erosion and reorientation of the islands (Meyer-Arendt and Wicker, 1982).

Overall, the islands have been subjected to extensive erosion, breaching, and subsequent opening of tidal inlets, and land loss. Terrebonne is fortunate however, that the extent of erosion caused by severe storms has been minimal over the past several years and we have not been subjected to the erosion forces of a major hurricane. However, if existing forces continued unchecked, all of Terrebonne's barrier islands will be gone in 50 years. Once these islands are lost, the destruction of Terrebonne Parish will accelerate drastically. With the loss of the islands and the estuary, Louisiana, Terrebonne and the nation will lose billions of dollars in renewable resources and recreational industries. In addition, the increased cost of hurricane protection will become staggering for the Terrebonne-Lafourche Metro Area, the United States' newest Metropolitan Statistical Area (MSA) in which approximately 200,000 people reside.

Despite the various physical processes that are contributing to the loss of the barrier islands, remedial measures can be implemented to retard this degredational phase. Various methods have been proposed to stabilize the Barrier Islands and information has been sought to either justify their use or to remove these methods from further consideration.

Structures such as

1. Rip rap
2. Groins
3. Breakwaters and
4. Sea Walls

were once proposed to stabilize the islands. Besides cost, available literature suggested that structural solutions such as groins, rip rap or

detached breakwaters are not generally recommended in areas of high shoreline retreat, unless accompanied by adequate sand nourishment.

Rip rap revetments protect only the land immediately behind them and provide no protection to adjacent areas. And when a groin is built, the sand trapped on its updrift side is no longer available to the downdrift beaches and erosion may result (USACE, 1981). Presently, East Timbalier and Timbalier Islands are being starved of sand by the jettie located at Belle Pass.

In 1975, the U.S. Army Corp of Engineers developed a plan for restorating Terrebonne's coast line (USACE, 1975). Although the alternatives considered were not economically justified at the time and therefore, not eligible for federal participation, analysis indicated that a closure dike alternative was the most satisfactory plan for meeting the planning objectives. However, the report goes on to say, "since the plan does not provide complete protection, other actions that are important to the plan should be implemented including regulation of dredging operations, placement of dredged material, and a beach stabilization program".

Based on the literature available, the parish recognized the need to pursue non-structural solutions. Non-structural alternatives include:

1. Beach Nourishment
2. Dune Construction and Stabilization
3. Back-Barrier Fill and Stabilization and
4. Sand Management Practices.

HOW THE BEACH WORKS

COMPONENT 1 RESPONSE TO : NORMAL WAVE CONDITIONS AND WEAK STORMS

Figure 2a

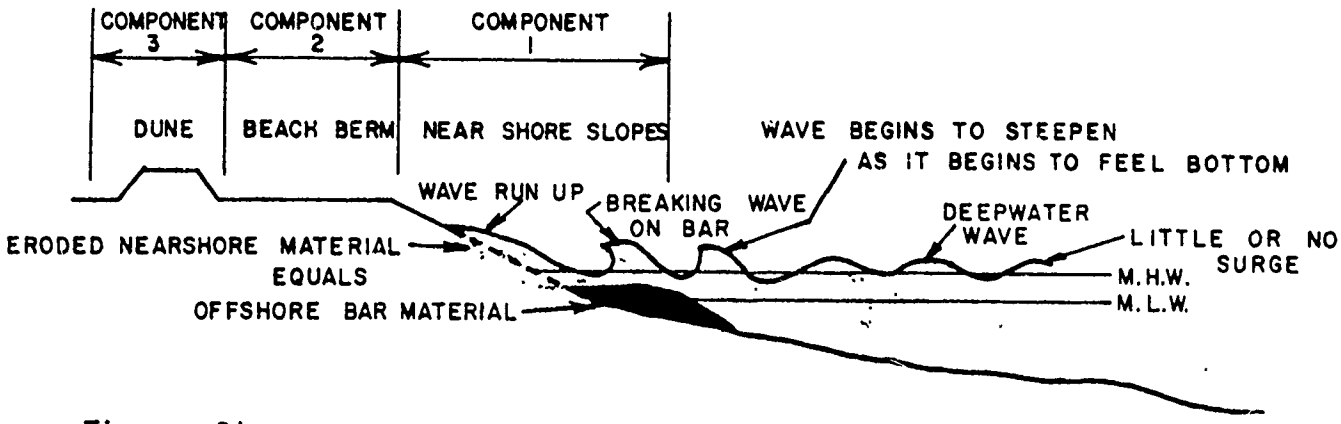
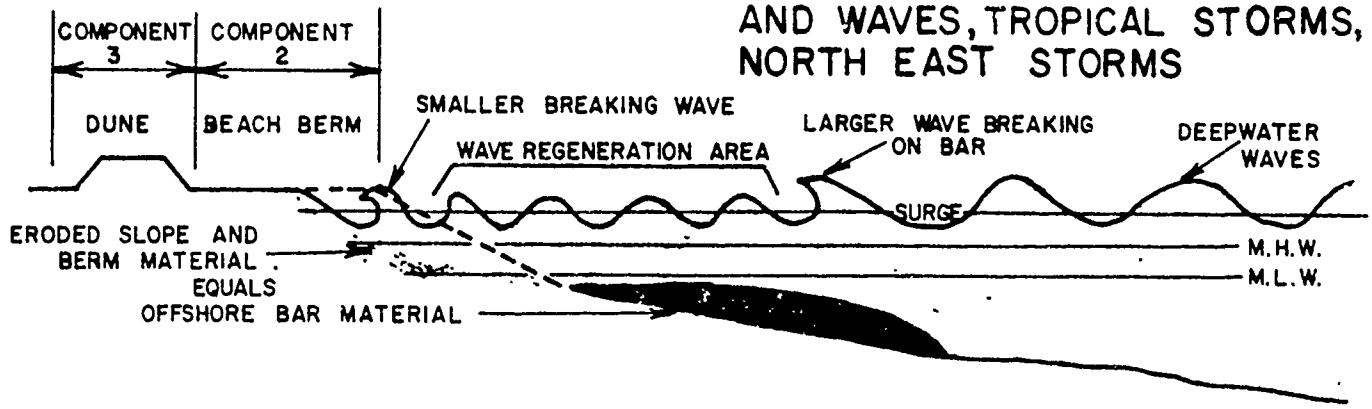


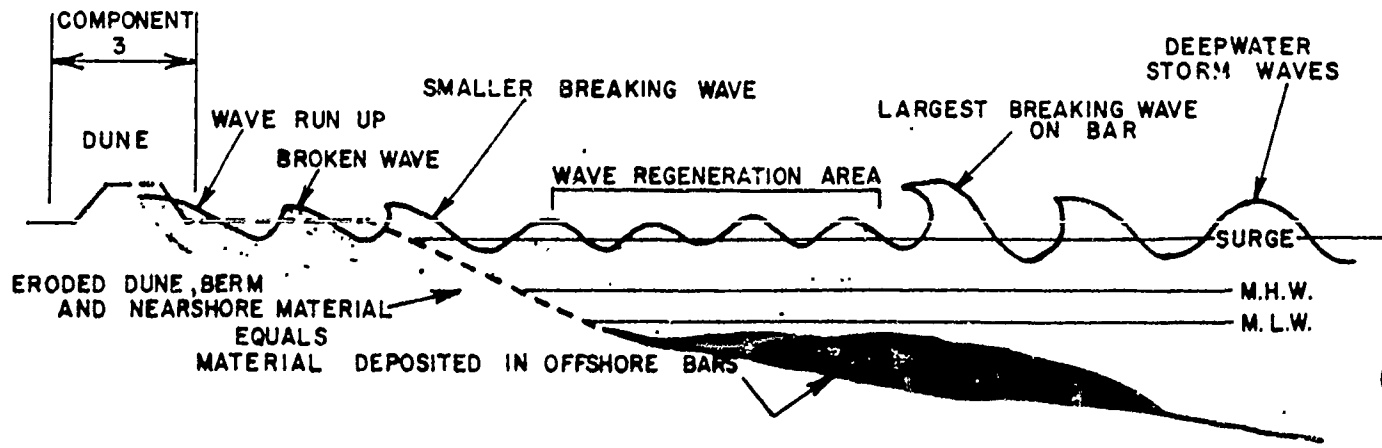
Figure 2b

COMPONENT 2 RESPONSE TO : WEAK HURRICANE SURGE AND WAVES, TROPICAL STORMS, NORTH EAST STORMS



COMPONENT 3 RESPONSE TO : MAJOR HURRICANE SURGE AND WAVES

Figure 2c



The Corp of Engineer's Shore Protection Manual (USACE, 1977) classifies beaches as shore protection structures. It states, "Such beaches disipate wave energy without causing adverse effects". The manual continues with, "When studying an erosion problem, it is advisable to investigate the feasibility of mechanically or hydraulically placing borrow material on the shore to restore or form, and subsequently maintain, an adequate protection beach". The Corp is currently doing this along Grand Isle.

With two opposing solutions facing the Parish efforts were intensified to search the available literature and to fund additional site specific studies. As a result of these efforts, a 1960 report by the Louisiana Department of Public Works printed as House Document 338, 87th Congress, 2nd Session was located. This report concluded, "The only suitable plan for protection of both the Timbalier and Isles Derneires chains would be the artificial nourishment of the beach front with material from the offshore gulf areas".

Then in 1982, the Terrebonne Parish Police Jury completed its first barrier island restoration plan. It states, "Shoreline erosion can be retarded by nourishing the beaches with introduced coarse sediments, and the loss of sand can be reduced by sealing off breaches and washovers and installing sand-trapping jetties in locations where longshore-migrating sand enters major sink areas". (Meyer-Arendt and Wicker, 1982).

In 1983, Terrebonne's second restoration plan was completed. The staff took this information and began to develop projects and design additional studies. To date these projects include:

1. Use of Cat Island Pass Dredge Material for Eastern Isle Dernieres Restoration Project.

Over the last 18 years the U.S. Army Corps of Engineers has contracted for eleven dredging projects of the Houma Navigational Canal in Cat Island Pass. In each of these projects, disposal of the dredged material has occurred in a designated subaqueous spoil area immediately adjacent to the Canal. Cat Island Pass is again scheduled for dredging in the summer of 1984. Terrebonne Parish proposes this years' dredge material be used for barrier island restoration at Eastern Isles Dernieres, approximately 5 miles to the west of the Houma Navigational Canal.

Approximately 440,000 yd^3 of material will be hydraulically transported from the dredge site and used as back bay fill to seal an existing washover at the eastern end of Eastern Isles Dernieres.

2. Back Barrier Fill on Eastern and Central Isles Dernieres.

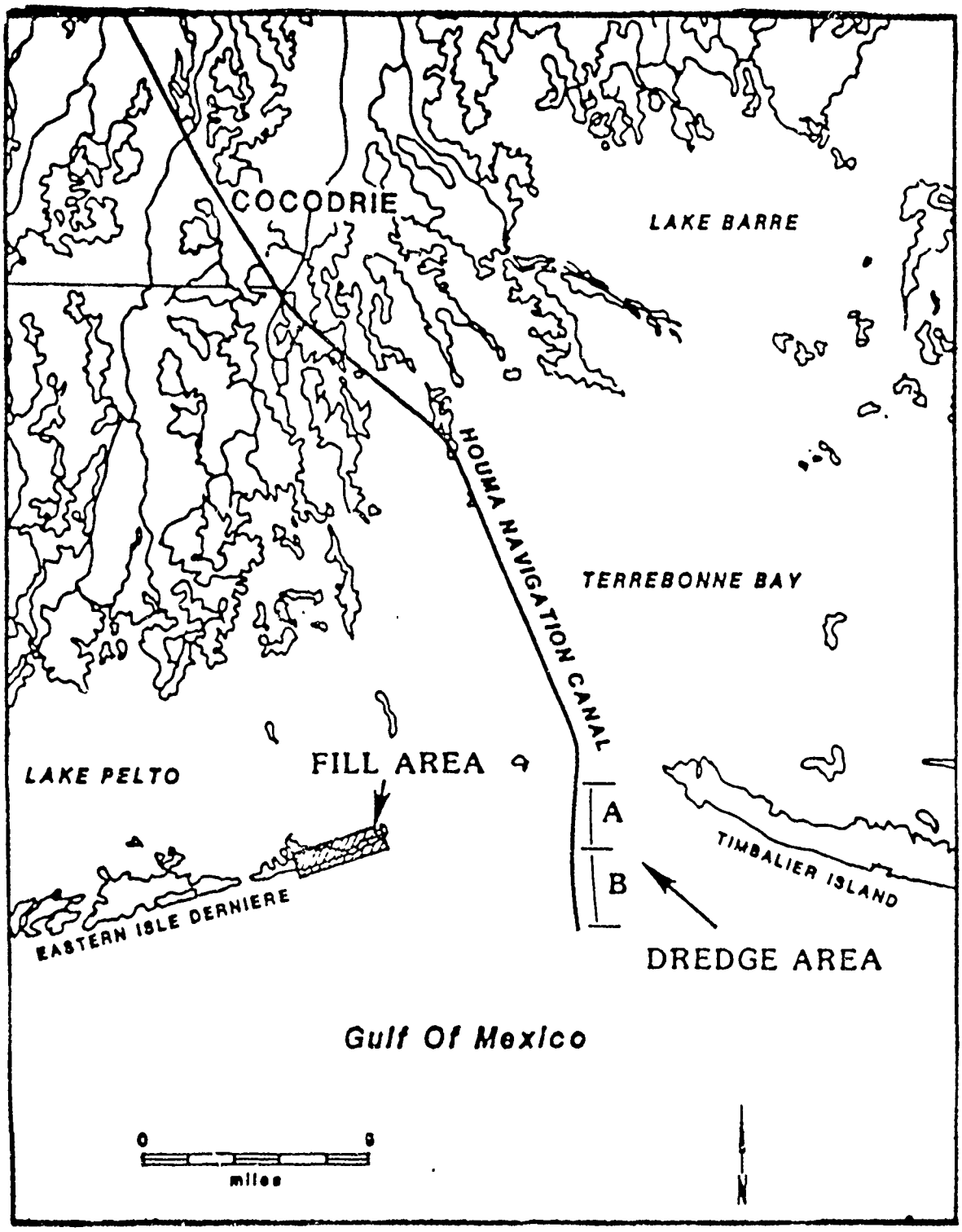
Terrebonne Parish plans to create back barrier marshes in six critical areas on Eastern and Central Isles Dernieres. Approximately 100 acres of back barrier marsh will be created by building up existing low dune and washover areas to a height compatible with the adjacent dunes and then placing locally dredged material behind the new beach dunes. This dredge material will be placed to elevations suitable for colonization by marsh grass and mangrove.

3. Beach Nourishment of Eastern Isles Dernieres.

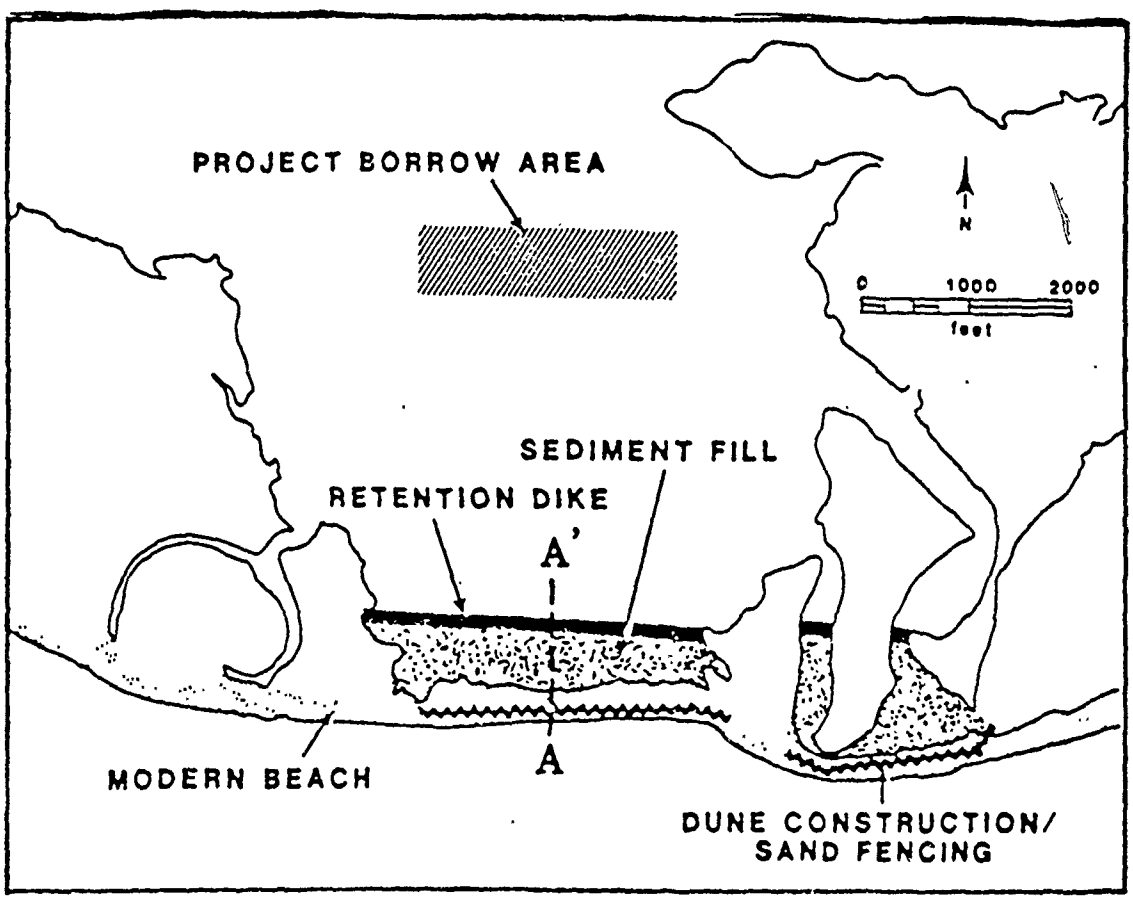
Terrebonne proposes to build a small sand ridge approximately four (4) feet high at its crest and approximately 100 feet wide on the beach of Isles Dernieres from Carmen Cut to Whiskey Pass. This sand emplacement would add outside sand to the Isles Dernieres system. It is anticipated that this sand would be used by natural systems to build offshore bars and beach for shore protection. In addition, the four (4) foot ridge would resist some washover that is occuring now. Vegetation would be planted on this ridge in a further effort to stabilize this beach system.

4. Sand Recycling System.

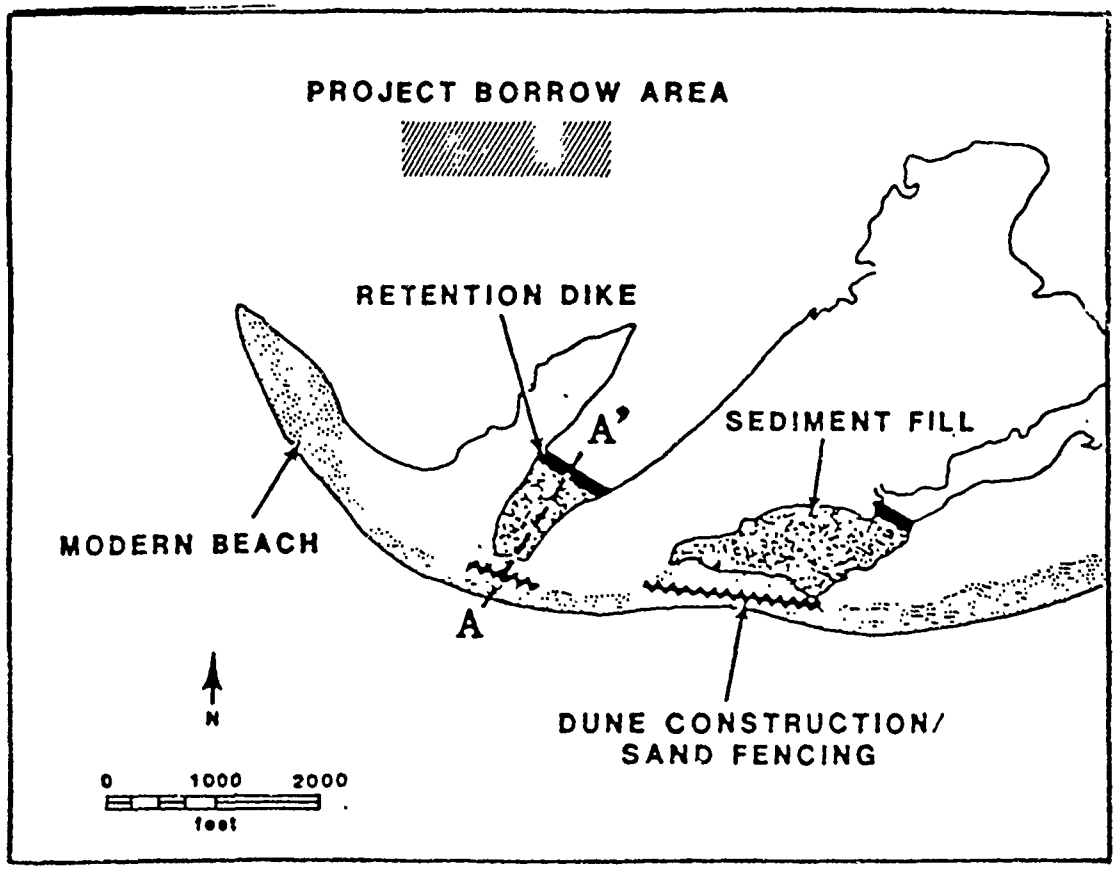
Terrebonne Parish intends to complete a sand recycling system to help preserve the Isles Dernieres chain upon completion of the previously mentioned projects. This system would consist of small jetties placed at the ends of Eastern and Central Isles Dernieres to trap migrating sand and the purchase of a small hydraulic dredge to recycle the trapped sand back onto the islands' beaches.



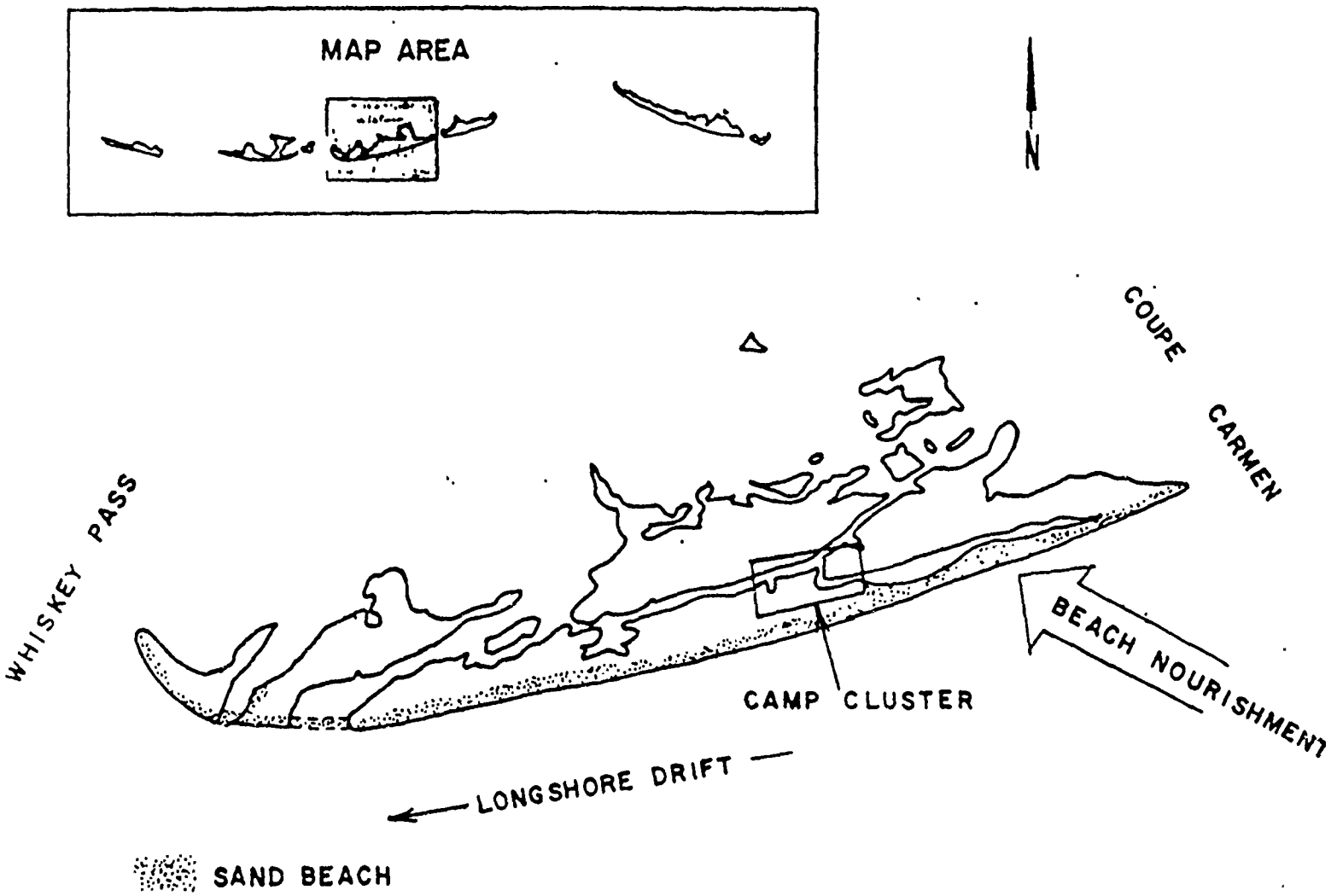
VICINITY MAP SHOWING LOCATION OF PROPOSED FILL AND DREDGE AREA FOR THE USE OF CAT ISLAND PASS DREDGE MATERIAL ON EASTERN ISLE DERNIERE.



PROJECT SITE MAP SHOWING PROPOSED WORK ELEMENTS FOR BACK BARRIER MARSH CREATION ON CENTRAL ISLE DERIERES.



PROJECT SITE MAP SHOWING TWO OF THREE PROPOSED WORK ELEMENTS FOR BACK BARRIER MARSH CREATION ON EASTERN ISLE DERNIERES.



EASTERN ISLES DERNIERES
BEACH NOURISHMENT PROJECT

1:50,000

0 1 2 mi

0 1 2 km

People and organizations who have been instrumental in developing these projects include:

Congressman Billy Tauzin

Congressman John Breaux

Senator J. Bennett Johnston

U.S. Soil Conservation Services

U.S. Army Corp of Engineers, New Orleans District Office
San Fransisco District Office
Mobile District Office
Jacksonville District Office
Waterway Experiment Station

U.S. Environmental Protection Agency

U.S. Department of Interior, Mineral Management Service, New Orleans, Los Angeles

Louisiana Center for Wetland Resources

Louisiana Geological Survey

Louisiana State University

Louisiana Department of Natural Resources

Louisiana Department of Transporation and Development, Office of Public Works

Coastal Environments, Inc.

Great Lakes Environmental Marine, Ltd.

Tenneco-LaTerre, Inc.

Louisiana Land and Exploration Company

Great Lakes Dredging Company

T.L. James, Inc.

T. Baker Smith and Sons, Inc.

Terrebonne Parish Government

III. CAPITAL CONSTRUCTION BUDGETS

Until the Corp completes its current investigation of Louisiana's wetlands and until federal participation in the Corp's closure dike program is justified, Terrebonne Parish intends to implement the Corp's, DOTD's, Coastal Environment's, Louisiana Geological Survey's and the Parish Staff's recommended actions of beach nourishment and stabilization. The first actions the Parish will undertake are the four (4) island restoration projects presented earlier in this report. In addition, the Parish has gathered and developed preliminary information to generate a twenty-five (25) year budget to plan, design and construct a comprehensive marsh management and hurricane protection program for Terrebonne Parish.

Following are budgets for a twenty-five year program. Today's emphasis is placed on the five (5) year and ten (10) year budgets for this program.

The budget for the first five years of the program depicts costs associated with the implementation of the projects described previously, including:

1. Cat Island Pass Use of Dredged Material
2. Back-barrier fill on Eastern and Central Isles Dernieres
3. Beach Nourishment of Eastern Isles Dernieres
4. Sand Recycling System

5 YEAR CAPTIAL BUDGET

AMOUNTS EXPRESSED IN THOUSANDS

PROJECTS	1984	1985	1986	1987	1988	TOTAL
Dune Construction	200	360	1,500		200	2,260
Back-Barrier Fill	600	740	1,500			2,840
Stabilization		150		700		850
Beach Nourishment				1,775	300	2,075
Sand Retention		500				500
Equipment/Maintenance					3,000	3,000
Montioring	100	50	50	50		250
Studies/Design	100	100	50	50	100	400
TOTAL	1,000	1,900	3,100	2,575	3,600	12,175

Beginning in 1984, material dredged from Cat Island Pass will be used to repair a wash-over fan on Eastern Isles Dernieres, followed by back-barrier fill and sand retention projects in 1985. In 1986, numerous wash-over fans will be repaired on Eastern Isles Dernieres followed by a protective beach nourishing of the Isles in 1987. To maintain the projects implaced in the four previous years, in 1988, the parish plans to purchase a small maintenance suction dredge. These projects, coupled with the State's closure of Carmen Cut will enable the Isles Dernieres chain to be stabilized and maintained with periodic nourishment, barring any damage caused by a tropical storm.

The second budget covers costs for the five year period beginning in 1989 and running through 1993. Again, as in the first five (5) year program, the second five (5) years is characterized by fill, stabilization and beach nourishment. Most of this work includes the introduction of sand retention devices to assist the maintenance dredge and, the design of a parish wide hurricane protection project.

SECOND 5 YEAR BUDGET

AMOUNTS EXPRESSED IN THOUSANDS

PROJECTS	1989	1990	1991	1992	1993	TOTAL
Dune Construction		200		200		400
Back-Barrier Fill		500		500		1,000
Stabilization	50	100			100	250
Beach Nourishment		500			500	1,000
Sand Retention	1,000	200				1,200
Equipment/Maintenance	500	500	500	500	500	2,500
Monitoring	50	50	50	50	50	250
Studies/Design			250	250	250	750
TOTAL	1,600	2,050	800	1,500	1,400	7,350

The remaining fifteen (15) year budget covers the years beginning in 1994 and ending in 2010 with the realization of a controlled estuary and hurricane protection system. This system will utilize a three (3) barrier control system consisting of the barrier islands and two levees. With the completion of this system the threat of sea level rise and tropical storms will be minimized.

LAST 15 YEARS BUDGET

AMOUNTS EXPRESSED IN THOUSANDS

PROJECTS	1994-1997	1998-2001	2002-2005	2006-2010	TOTAL
Barrier Island					
Maintenance	2,000	2,000	2,000	2,000	8,000
Levee Construction	26,880	26,880	26,880	26,880	107,520
Flood Gates	15,000	7,500	7,500	7,500	37,500
Water Controls	1,000	1,000	1,000	1,000	4,000
Monitoring	200	200	200	1,000	1,600
Studies/Design	500	500	500	500	2,000
TOTALS	45,580	38,080	38,080	38,080	160,620

Combining the totals of each budget results in a twenty-five (25) year system cost of $180,145,000. These costs are expressed in 1980 dollars and therefore, do not take into account inflation over the twenty-five (25) year period. Also, and most importantly, these figures reflect solutions for a specific situation in a constantly and rapidly changing environment. Because of this any program has to be extremely flexible.

25 YEAR TOTALS

AMOUNTS EXPRESSED IN THOUSANDS

PROJECTS	TOTAL
Dune Construction	2,660
Back-Barrier Fill	3,840
Stabilization	1,100
Beach Nourishment	3,075

PROJECT	TOTAL
Sand Retention	1,700
Equipment/Maintenance	13,500
Levee Construction	107,520
Flood Gates/Water Controls	41,500
Monitoring	2,100
Studies/Design	3,150
TOTAL	180,145

Although Terrebonne has spent and allocated over $1.3 Million of local funds over the past several years to combat erosion, solutions are beyond our capacity. For this reason, it is hoped that the State of Louisiana will choose to support Terrebonne's effort to preserve its barrier islands and, as you will soon hear, its valuable wetland resources.

Sources of funding for the proposed projects are summarized accordingly:

SOURCES	1984-1988	1989-1993	1998-2010	TOTAL
Local	3,000,000	2,500,000	11,600,000	17,100,000
State	9,175,000	4,850,000	30,000,000	44,125,000
Federal	-0-	-0-	119,020,000	119,020,000
TOTAL	12,175,000	7,350,000	160,620,000	180,145,000

IV. ECONOMIC JUSTIFICATION

Louisiana's 6.5 million acres of wetlands constitute 40% of the nations marsh ecosystem. Ten percent of these Louisiana wetlands are located in Terrebonne Parish. These wetlands are a vast, unique, natural factory for the production of renewable resources and the location of much of its mineral resources.

Louisiana's shrimp production has been estimated to be worth approximately 50 million dollars annually. The oyster catch in Louisiana has a yearly value between three and four million dollars.

Louisiana's Mississippi River delta has been determined to be one of the nation's most productive menhayden fishing areas. In its early life, menhayden are dependent on an esturine environment for survival. Being king by weight, "the menhayden catch has made the ports of Cameron, Empire-Venice and Dulac-Chauvin among the top five fishing ports in the United States. Combined, these ports account for more that 850 million pounds, which represent more than $80 million in annual income" (Davis, 1984).

Louisiana's fur industry accounts for as much as 65% of the nation's fur harvest. The value of this harvest varies greatly from year to year. Its yearly value is estimated to be between $2 million and $24 million annually.

Terrebonne Parish's wetlands are conservatively estimated to produce seafood and fur products valued annually at 13.5 million dollars.

The hunting and fishing recreation industry contributes $175 million to $200 million to the state economy. Ten to twenty percent of this industry is located in Terrebonne Parish.

In addition to her renewable resources, much of Louisiana's non-renewable resources lie within its wetlands. Much of this mineral wealth is represented by the production of oil and gas. Terrebonne is one of Louisiana's top oil and gas producing parishes.

In spite of proposed legislation, the base line for determination of the Federal-State boundary is considered as an ambulatory line. Recently, the state has been advocating increased Louisiana participation and revenues from Section 8-G lands.

The present Federal-State boundary is based on a 1953 photo survey of the Louisiana Coast Line. As emphasized in this presentation and other references, the shoreline has eroded considerably during the last 30 years so the boundary based on 1984 data would be considerably landward from that which is in use today.

If nothing is done to reduce shore line erosion, the Federal-State boundary, if resurveyed, will continue to move northward and reduce Louisiana's participation in petroleum industry income. If an island such as Isle Derniere were lost, dramatic changes in the Federal-State boundary would result along with decreased state and local revenues.

As can be seen, Terrebonne Parish's wetlands are of immense value, particularly to the state of Louisiana. The average projected expenditure per year for the 25 year program to protect this valuable ecosystem is 7.2 million dollars. The maximum yearly budgeted expenditure in the first five years of this program is two million dollars. Compare this to Terrebonne's estimated 13.5 million dollar seafood and fur production. This favorable comparison does not even consider the value of Terrebonne's wetlands to the oil and gas industry or its sport fishermen and hunters.

V. CONCLUSION

Man has no control over the natural processes that have for centuries affected the coast. The man-made elements that have altered flow regimes, sediment patterns and vegetative assemblages have created a problem. The wetlands are out of balance. Land loss forces now supercede constructive forces thus threatening the jobs, industries and lifestyles of the people whose lives are tied directly or indirectly to the coast. The final question is: "Can we afford the loss?" (Davis, 1984)

We, of Terrebonne Parish feel the only answer to this question can be No. It is hoped that the State of Louisiana would feel the same and support Terrebonne's efforts to preserve and maintain its unique and valuable wetland.

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Houma-Terrebonne Chamber of Commerce. "Economic and Cultural Consequences of Land Loss in Terrebonne Parish". Terrebonne Magazine, July (1984).

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Barrier Islands from Racoon Point to Belle Pass: Abridged Report on Beach Erosion Control Study. Louisiana Coastal Area Study: 1975.

The Barrier Islands of Terrebonne Parish: Restoration Potential. Prepared for Terrebonne Parish Police Jury by Coastal Environments, Inc. Baton Rouge, Louisiana: 1982.

Belle Pass to Racoon Point, Louisiana Beach Erosion Control Study. U.S. Army Corps of Engineers (USACE). House Document #338, 87th Congress, 2nd Session: 1960.

Mississippi Deltaic Plain Region Habitat Mapping Study. U.S. Fisheries and Wildlife Service, Office of Biological Services. FWS/OBS-79-07: 1980.

Shore Protection Manual. 3rd Edition. Coastal Engineering Research Center, Volume I, II and III. U.S. Government Printing Office, Washington, D.C.: 1977.

OFFERED BY: Mr. W. Henry.
SECONDED BY: Mr. W. Bonvillain, Jr.

RESOLUTION NO. 84-0969

A Resolution offering comments on the U.S. Army Corps of Engineers initial evaluation study on water supply, land loss and marsh creation and shore and Barrier Island erosion.

WHEREAS, the Corps of Engineers has scheduled public hearing to receive comments on said matter, and

WHEREAS, these initial studies determine the focus of future feasibility studies, and

WHEREAS, the Terrebonne Parish Government has been strongly concerned with the state of deterioration of its environment, and

WHEREAS, that although the Corps of Engineers must be commended for taking these directions and are encouraged to continue their research, the parish feels that the information presented in the Notice of Findings for each study is incomplete and insufficient to support the conclusion, and

WHEREAS, the parish has determined that the only successful long term approach to curing the symptoms of larger problems is to address the problem of the total eco-system, and

WHEREAS, the Terrebonne Parish Government has developed a program to identify, address and manage the problems of its eco-system.

NOW, THEREFORE BE IT RESOLVED that the Corps continues its research but re-evaluates all alternatives presented in the initial studies during the feasibility stage; and,

BE IT FURTHER RESOLVED that these evaluations be closely tied to existing local government plans, studies and reports and that the future feasibility studies be conducted with close cooperation with local government; and,

BE IT FURTHER RESOLVED that the Corps respond to the following questions concerning the initial studies:

1. In all studies, how were annual project cost, both construction and maintenance, calculated and over what period of time?

2. In all studies, how were project benefits calculated, what values were used and over what period of time?

3. Did the salt water barrier alternative under the water supply study take into account its value to protect against erosion?

4. Did the marsh creation and barrier island studies examine the use of material dredged under the Corps maintenance dredging operation?

THERE WAS RECORDED:

YEAS: P. Gabriel, Sr., N. Bolden, C. Davidson, A. Bonvillain, B. Bonvillain, N. Bergeron, Jr., L. Klingman, Jr., R. Bergeron, W. Bonvillain, Jr., U. Guidry, R. Domangue, W. Henry, C. Bodden and C. Duet.

NAYS: None.

NOT VOTING: J. D. Boudreaux III.

ABSENT: None.

The Chairman declared the Resolution adopted on this 22nd day of August, 1984.

* * * * * * * * * * *

I, PAUL A. LABAT, Clerk of the Council of Terrebonne Parish, Louisiana, do hereby certify that the foregoing is a true and correct copy of a Resolution adopted by the Council in Regular Session on August 22, 1984, at which meeting a quorum was present.

GIVEN UNDER MY OFFICIAL SIGNATURE AND SEAL OF OFFICE THIS 23rd day of AUGUST, 1984.

Paul A. Labat

PAUL A. LABAT
COUNCIL CLERK
TERREBONNE PARISH COUNCIL

September 10, 1984

Colonel Robert C. Lee
District Engineer
New Orleans District
Corps of Engineers
P. O. Box 60267
New Orleans, LA 70160

Dear Colonel Lee:

The Greater Lafourche Port Commission would like to commend the Corps on studies of Water Supply, Land Loss and Marsh Creation, and Shore and Barrier Island Erosion. We believe that these problems are paramount to Louisiana and this nation, and strongly urge further action by the federal government.

The Commission would like to make several comments concerning these very important studies.

As I and several others stated at the public hearing held in Houma, parameters used to determine the cost-benefit ratio needs to be examined. I have not had the opportunity to review exactly how these ratios were determined, but this Commission feels the Port Fourchon beach area has been delt a great injustice by the cost-benefit ratio determined in the study. Port Fourchon has developed into a strategic multi-use port that has local, state and national significance (see enclosed brochure). Over a billion dollars is invested there. Beach stabilization is a must in protecting this thriving port. The recreational usage of beach area is phenomenal since it is one of the few beaches in this state that had road access. This road access is being threatened by the Gulf today and will no longer be available unless something is done immediately. The Greater Lafourche Port Commission strongly urges the Corps to re-evaluate the cost-benefit ratio of stabilizing Fourchon Beach, especially the immediate area fronting the port and road access.

In the water supply study, Grand Isle was considered a problem area. We urge that the Corps work very closely with the Lafourche Parish Fresh Water District in its further studies. Port Fourchon is also on the same water line as Grand Isle and its water needs are tremendous and barely being met by the District. Importing 700,000 gallons a day from Leeville would affect the Port greatly and would not be practical. It is also my understanding that the weak link in getting water to the south end of the parish is in the Golden Meadow area and a larger line to Leeville from Grand Isle would not benefit.

Greater Lafourche Port Commission · P.O. Drawer 728 · Galliano, La. 70354 · (504) 632-6701

The Commission strongly supports the Davis Pond Freshwater Diversion Project and opposes any alternative that would convert it to a storage reservoir or otherwise interfere with freshwater diversion into the Barataria Basin.

The Commission strongly supports prevention of land loss and marsh creation projects. We believe a project similar to the Grand Isle Beach project should be initiated at Port Fourchon before beach access is lost and the Port itself jeopardized.

If this Commission can be of any assistance to you in these projects, please do not hesitate to contact us as we are very interested in the future of our coastal zone.

Yours very truly,

Ted M. Falgout
Executive Director

TMF:lad
Enclosure

SOUTH LAFOURCHE LEVEE DISTRICT
BOARD OF COMMISSIONERS
POST OFFICE BOX 426
GALLIANO, LOUISIANA 70354
(504)632-7554

August 30, 1984

Robert C. Lee, Colonel CE
District Engineer
Department of the Army
New Orleans District, Corps of Engineers
P. O. Box 60267
New Orleans, LA 70160

Attention: Planning Division
Regional Planning Branch

Dear Sir:

The Board of Commissioners of the South Lafourche Levee District is in favor of the entire concept of action which will enhance the marsh-bay estuarine environment. We feel that enhancing the marsh surrounding our hurricane protection levee will reduce the amount of wave energy which might reach our levee. Barrier island stabilization will absorb storm energy, restrict salt water intrusion, and help stabilize the delicate marsh environment.

We ask that projects which have positive effects upon each other be studied together. This type of effort will result in better benefit/cost ratios. We also believe the best rational is to attack the coastal problems by associating the plans to make one cohesive effort. We suggest that projects which compliment each other be constructed at the same time.

We are appreciative of the opportunity to comment on these projects.

Very truly yours,

SOUTH LAFOURCHE LEVEE DISTRICT

Windell A. Curole

Windell A. Curole
General Manager

WAC/jr

Environmental Law Reporter
1346 Connecticut Ave. NW • Washington, DC 20036 • (202) 452-9600

Mr. Pete Hawxhurst
Department of the Army
New Orleans District, Corps of Engineers
P.O. Box 60267
New Orleans, La. 70160

Dear Mr. Hawxhurst:

I was very interested to read about your marsh creation report in a recent article. I have been interested in and concerned about the habitat loss ensuing from loss of wetlands for some time, and so have been interested and encouraged by reports on efforts like yours. Are you familiar with similar efforts on the LaSalle River in Illinois by Wetlands Research, Inc.? Also, I understand that TVA is working to create wetlands along the shores of some of their artificial lakes.

Would you please send me a copy of your study--"Land Loss and Marsh Creation: Initial Evaluation Study"? Also, if you have other information about other wetland creation efforts, I would greatly appreciate copies of or references to that material.

Thank you for your consideration of these requests. Wishing you good luck and wisdom in this project, I am

Sincerely yours,

Jim Conner
Associate Editor

Houma-Terrebonne Chamber of Commerce

1700 South St. Charles Street
(504) 876-5600

P.O. Box 328
Houma, Louisiana 70361

August 28, 1984

Robert C. Lee, Colonel
Department of the Army
New Orleans District
Corps of Engineers
P. O. Box 60267
New Orleans, Louisiana 70160

Dear Colonel Lee:

The Houma-Terrebonne Chamber of Commerce is a voluntary organization of business and professional people who devote their time and energies toward community betterment programs. We represent over 600 employers in Terrebonne Parish whose employees number in excess of 24,700 people, providing a livelihood for approximately 57,580 people among a total parish population of 100,300.

The Chamber of Commerce has for many years voiced concern about the issues of raw water supply, land loss and shore and barrier island erosion. The Chamber therefore is particularly enthusiastic about the involvement of the U. S. Army Corps of Engineers in preparing these Initial Evaluation Studies.

We view each of the topics under consideration: water supply; land loss and marsh creation; shore and barrier island erosion to be complimentary of each other and that their implementation would have a mutual positive impact.

RAW WATER SUPPLY

The Chamber has two basic concerns relative to raw water supply. First is the concern for a raw water supply for potable water needs as addressed in the Initial Evaluation Study. Secondly, is the concern for a source of fresh water for industrial development purposes.

With regards to the first concern, the alternatives mentioned in the

initial report appear to be viable. In addition to these there are possibly other alternatives that should be considered. Examples of these might be as follows:

A) The introduction of fresh water into Bayou Terrebonne at a point southeast of the City of Thibodaux through an open canal or flume, which would accomplish two objectives:

1) A continuing flow of fresh water through Bayou Terrebonne would aid in the beautification and cleanliness of the bayou.

2) A raw water line might be constructed from Bayou Terrebonne above a wier constructed at its intersection with the St. Louis Canal to the existing water treatment plants, thus reducing the cost of the raw water line from Raceland.

B) The construction of a flume from the Lake Palourde or Grassy Lake area into Terrebonne Parish via Big Bayou Black with the ultimate introduction of large quantities of raw water for both potable and industrial use. This might require the construction of an inverted siphon to take the Lafourche-Terrebonne drainage canal under Big Bayou Black and U. S. 90, and a canal along the section line between sections 17 and 18, T17S R15E south of U. S. 90 to its intersection with an existing drainage canal.

C) The possible introduction of water from Bayou Lafourche northwest of the City of Thibodaux into the Terrebonne-Lafourche or the Phillips drainage canals. This alternative might require two additional control structures, one in Bayou Black and one on the new flume at Bayou Lafourche. During periods of high salinity, the existing flood gates on Minors, Elliot Jones and Shell canals, and the new gate on Bayou Black could be closed. The effect of introducing Bayou Lafourche water into this drainage system would have to be evaluated.

The second concern, that of raw fresh water for industrial development purposes, could in part be addressed by either B or C above. In this regard, the area of most potential for industrial development is probably along the Houma Navigational Canal. The Corps' study should address the problem of how to get large volumes of raw fresh water across the Intracoastal Canal and into Bayou Dularge and Bayou Grand Caillou to facilitate industrial development along the canal.

The area of second most potential is probably west of the City of Houma between Big Bayou Black and the Intracoastal Waterway. This area could obtain industrial raw water from Big Bayou Black with proper water use management.

As most of the solutions appear to depend upon water from Bayou Lafourche, the Corps' attention is invited to the existence of the

Lafourche Fresh Water District, which does not include Terrebonne Parish, and the potential problems this situation might present.

SHORE AND BARRIER ISLAND EROSION

During the past 20 years we have witnessed an accelerated rate of erosion along Louisiana's shoreline and the barrier islands which presents a danger to coastal development, to a productive fish and wildlife area, and to numerous recreation activities. The island chains off the Louisiana coast serve as a barrier for the inland coastal area by protecting a very productive and environmentally sensitive marsh complex. As the islands diminish in size we see an increase in saltwater intrusion and a more severe impact of storm tides on our delicate marshlands.

The Corps of Engineers Initial Evaluation Study has identified two (2) plans which are economically feasible. The two recommended plans include plans for Timbalier Island and Isle Dernieres (in Terrebonne Parish) and a plan for Holly Beach and vicinity. We believe the plans for the Terrebonne Barrier Islands as identified in the Initial Evaluation Study have merit which deserve further evaluation. The Houma-Terrebonne Chamber of Commerce supports the Corps in their efforts to conduct a feasibility study of these two plans as well as the other 6 plans which appear to be sound.

LAND LOSS AND MARSH CREATION

The Initial Evaluation Study by the Corps confirms that land loss is a serious problem throughout the coastal zone and Terrebonne Parish is no exception. We cannot over emphasize the economic value of our marshes and swamps for the fishing industry, for industry, recreation and the valuable mineral resources which lie beneath. In addition this area enables us to develop and maintain waterborne commerce, provides fresh drinking water and protection from storm tides.

The Corps has identified the causes, magnitude and the adverse economic impact which results as the wetlands vanish. In your search for possible solutions you have identified methods to use in plans to combat land loss. The two methods which you found to be economically feasible are by creating marsh with material from maintenance dredging of existing navigation channels and diversion of sediment laden water from the Mississippi river. We support your efforts to develop more detail on these two possible solutions to land loss.

In summary, the Houma-Terrebonne Chamber of Commerce feels that the Corps of Engineers has identified very viable methods

which have the potential to protect and improve our fresh water supply, to reduce land loss and to control erosion along our shoreline and barrier islands. We also support your recommendations that additional studies are needed before any of these plans are implemented.

We appreciate having had the opportunity to submit our views on the subject of this hearing and we extend our cooperation in pursuit of solutions to these complex issues.

Yours very truly,

Kenneth Watkins
President

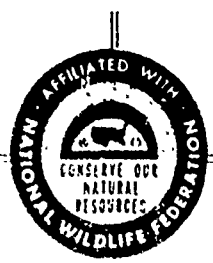
KW/kb

That concludes our comments. Thank you for the opportunity to participate.

Sincerely,

Virgil J. Bourque, Jr.
President

VJBJr/sp
cc: Hon. Russel Long
Hon. J. Bennett Johnston
Hon. Robert Livingston
Hon. Lindy Boggs
Hon. Billy Tauzin
Hon. John Breaux
Members, LWF Wetlands Committee



Louisiana Wildlife Federation, Inc.

P.O. BOX 16089 LSU
BATON ROUGE, LOUISIANA 70893
504/355-1871

September 5, 1984

New Orleans District
U.S. Army, Corps of Engineers
P. O. Box 60267
New Orleans, Louisiana 70160

Attn. Planning Division
Regional Planning Branch

re: Study Findings - Water Supply, Land Loss and Marsh Creation, and Shore and Barrier Island Erosion in the Louisiana Coastal Area

Dear Sir:

We submit these comments for the record of the meetings held last month concerning the captioned subjects. The Louisiana Wildlife Federation is the largest non-government conservation organization in the state with 80 local affiliate sportsmens groups and over 7,000 members. Well over half of our members reside in or within a short drive of Coastal Louisiana and utilize its resources for both commercial and recreational purposes. Thus we are vitally interested in any proposals intended to halt further deterioration and/or restore losses of coastal resources.

The effort the Corps ofEngineers has made to identify the problems in Coastal Louisiana, the causes and solutions, is commendable. Certainly the Louisiana Wildlife Federation, in general, supports all proposals to restore wetlands, improve water quality and offset beach and barrier island erosion. Particularly with regard to the study of Land Loss and Marsh Creation, however, more emphasis should have been directed toward treating the cause of the problem rather than compensating for the effects.

WATER SUPPLY

The rationale for Corps involvement in studying solutions to the water supply problems of Grand Isle and the River Parishes is not clear to us. The suggestion that the ongoing planning for freshwater diversion to the Barataria and Breton Sound Basins be complicated with provision for emergency water supply for the River Parishes is unacceptable. The justification for such an emergency supply is given in the study as a serious pollution event on the Mississippi River contaminating the existing supply source. We submit that the solution is to provide adequate pollution control regulation and enforcement to keep the River water acceptable for public supply use, not construct an alternate source that could likely compromise the benefits of much needed freshwater diversion.

The cause of the water supply problem in the four other problem areas is attributable to some extent to contamination of existing supply by encroaching saltwater. The maintenance of navigation channels such as the Calcasieu Ship Channel, Gulf Intracoastal Waterway, Houma Navigation Channel and Lower Mississippi River has contributed in varying degrees to the problem, along with over-pumping, waste, and municipal and industrial pollution.

The Houma Navigation Channel (HNC) presents a particularly severe problem. Saltwater conducted by this channel has devastated surrounding swamp forest and marshland. Though the Corps report dismisses construction of a saltwater barrier in the channel as too risky because of disruption in the movement of marine organisms, we suggest that every effort should be made to stop this saltwater problem for both water supply and land loss considerations. The impact of the HNC on surrounding wetland habitat is startling and deplorable.

SHORE AND BARRIER ISLAND EROSION

As funds are made available, we support the implementation of erosion plans for all eight problem areas studied by the Corps, with the priority based on significance of resources protected and benefit/cost ratio.

LAND LOSS AND MARSH CREATION

We are pleased to see the Corps acknowledge the major causes of land loss in the coastal zone, including various purpose canal dredging and flood control and navigation works on the Mississippi River. We emphatically concur with the Corps' evaluation that marsh creation using the maintenance dredging spoil from 8 major navigation channels should be pursued. We also support further consideration of controlled and uncontrolled Mississippi River diversions and use of Mississippi River sediments to bolster subsiding marshes.

There seems, however, to be an obvious oversight in this study. Though the Corps accurately attributes land loss, at least partially, to man's activities, particularly canal dredging and maintenance for navigation and access, it does not suggest any remedies directed toward these problem sources. Backfilling or removal of spoil that impedes freshwater flow through the marsh, plugging of canals, better coordination of activities so as to minimize adverse impacts - all would serve to reduce the rate of wetland deterioration.

Coastal Louisiana is suffering from the cummulative impacts of thousands of public and private projects undertaken, for the most part, without regard for the hydrology of the natural systems that created it. Every effort should be made to mitigate the impacts of previous and existing projects and activities, public and private, and future activities should be planned so as not to further disrupt these important wetland ecosystems, with particular attention paid to the natural hydrology at each project site.

ACADIA PLANTATION
P.O. BOX 110
THIBODAUX, LOUISIANA 70302

August 31, 1984

Col. Robert C. Lee
Corps of Engineers
District Engineer
New Orleans District
P. O. Box 60267
New Orleans, Louisiana 70160

C-7.1

Dear Sir:

As a private citizen, with no special representation, I attended the Corps' public meeting held in Houma, Louisiana, on August 28. The meeting was of great interest to me, partly because of my appreciation for and enjoyment of the uniqueness of our coastal areas and partly because of my residence on the banks of Bayou Lafourche, a distributary stream which was included as part of the discussions at the meeting.

I wish to offer some comments for the record both on general and specific bases.

As a general matter, it appears to me from the discussions which were held at the meeting that the various projects which were being discussed (and another which was not discussed in depth but which involves fresh water diversion to the Barataria and Breton Sound Basins) are being studied without adequate concern for inter-relationships. There appears to be a strong need for these studies to become part of a total management approach to the coastal zone area and even a possible rethinking of the coastal zone boundaries to include fresh water sources which may lie north of those present boundaries.

A surprising, almost comical, example of such a need for coordination was the recommended plan for fresh water reservoirs for Davis Pond and Big Mar, at the exact points where fresh water diversions to the Barataria and Breton Sound Basins were recommended under a previous study. It was apparent from the meeting and from the Corps' reports that those two projects - the diversion project and the fresh water reservoir project - would conflict in many ways.

Close to home, I am concerned about the water supply problems which were addressed in relation to Houma's needs but which would involve diversion of fresh water from Bayou Lafourche. Already, Terrebonne Parish takes a great amount of fresh water from Bayou Lafourche, which is presently suffering from serious salt water intrusion as far north as Lockport but noticeably also up to Thibodaux at certain times. How would increased use of Bayou Lafourche water be made possible?

It would appear that no one yet has addressed the need for a radical change in the hitherto conventional thinking of allowing Bayou Lafourche to become a drainage canal, non-navigable, with settlement allowed down to, and in some cases out into, the water, with fixed bridges on pilings where bridge crossings are built, and with no dredging of silt. If Bayou Lafourche is so crucial to the fresh water supplies for communities within the Lafourche basin, should not the Corps of Engineers also consider the feasibility of and need for a small diversion project at Donaldsonville? Should there not be a consideration of resumption of navigation along northern Bayou Lafourche, not only to provide for maintenance of the depth of the Bayou but also to make possible the economic diversity resulting from navigation? Should there not be some exploration of the possibilities of using Bayou Lafourche for additional fresh water diversion into marshes south of Raceland, where salt water intrusion is becoming a serious problem?

Further extensions of the problems, which were not fully discussed at the meeting, are those of drainage. I am an owner of property which straddles the Bayou Folse Watershed at its northern end. We frequently hear complaints of the inability of this watershed to carry run-off which has been caused by improved agricultural practices or urbanization. Those in-the-know are aware that one cause of the problem is silt blockage at the discharge areas of this watershed, namely at Lake Fields and areas below. Is the Gulf's intrusion adding to the problem? Might such drainage facilities be utilized to assist in stemming the salt water intrusion and marsh losses? Similar questions are valid on the left descending bank of Bayou Lafourche, where Grand Bayou, Bayou Boeuf, and other streams drain the Chackbay and Lafourche ridges.

I thank you for your consideration.

Sincerely,

David D. Plater

DDP/dj

cc: Congressman Billy Tauzin
Senator J. Bennett Johnston
Senator Russell Long

BILOXI MARSH LANDS CORPORATION
620 RICHARDS BUILDING
NEW ORLEANS, LOUISIANA 70112

June 14, 1976

Dear Lynn,

I wrote a follow-up letter last week to the Department of the Army, New Orleans District, Corps of Engineers, due to the fact that I had no response to my initial letter in connection with the placing of dredged material along the north side of the Mississippi River Gulf Outlet.

I enclose herewith the reply of June 10, 1976 from the Corps from which you will note that our request has been refused due to "the value of the marsh" which exceeds "that of the land on the south where dredged material has been placed".

The letter from the Corps settles the matter for the time being at any rate as I see it. If you have any further suggestions please let us have them.

Best wishes.

Sincerely,

Joyce

Joyce E. Moses

JEM:
Enclosure

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P. O. BOX 60267
NEW ORLEANS, LOUISIANA 70160

LMNOD-ND

10 June 1976

Mr. William W. Ogden, Vice President
Biloxi Marsh Lands Corporation
620 Richards Building
New Orleans, Louisiana 70112

Dear Mr. Ogden:

Reference is made to your letter of 29 April 1976 requesting that dredged material be placed along the north side of the Mississippi River-Gulf Outlet on land owned by Biloxi Marsh Lands Corporation.

Placing dredged material on the land along the north side of the Mississippi River-Gulf Outlet (MR-GO) would be contrary to the design memorandum and the environmental impact statement for this project. Supplements to these documents would have to be prepared and approved before any change in disposal areas, such as the one you suggest, could be effected.

The land on the north side of the MR-GO is prime marsh and is extremely valuable because of its high production of detritus, a vital ingredient in the food web of commercial fish and shellfish. This marsh also supports large numbers of mammals, birds and reptiles. Placing dredged material on this marsh would either partially or totally destroy it, depending on how much dredged material is placed. Any such action would trigger extensive opposition from environmental groups and a number of Federal, state and local agencies.

It is realized that a wide variety of wildlife is attracted to areas such as those along the south side of the MR-GO where dredged material has created a variety of habitats and vegetation. However, because of its high detrital contribution to fisheries, the value of the marsh on the north side of the channel far exceeds that of the land on the south where dredged material has been placed.

LMNOD-ND 10 June 1976
Mr. William W. Ogden, Vice President

In view of the above, it is necessary that I disapprove your request.

Sincerely yours,

L. A. HUBERT, JR.
LTC, CE
Acting District Engineer

February 3, 1976

Dear Joyce:

I have requested that the Army Corps of Engineers consider deposits of dredge material along the north side of the M.R.G.O.. The deposits could be made part of the maintenance dredging program. This would develope new marsh from small bays or ponds and help to provide some erosion control on the north shore of the channel.

The Corps did not answer my letter. Would you request the same from the property of Biloxi Marsh Lands Corp? At the present rate of erosion we have no time to loose.

Urgently yours,

Lynn Gagnon

Rec'd 8/27/84 Belle Chasse

Statement of Sherwood M. Gagliano

Coastal Environments, Inc.
1260 Main Street
Baton Rouge, Louisiana 70802

On the Occasion of the New Orleans District
U.S. Army Corps of Engineers
Public Meeting Concerning
the Louisiana Coastal Area Inital Evaluation Studies of
Water Supply, Land Loss and Marsh Creation,
Shore and Barrier Island Erosion

August 27, 1984
7 p.m.
Belle Chasse Auditorium
Belle Chasse, Louisiana

Statement for the Public Record

presented at the Public Hearing
sponsored by the U.S. Army Corps of Engineers
Cameron, Louisiana
August 30, 1984

by Klaus J. Meyer-Arendt

Coastal Environments, Inc.
1260 Main Street
Baton Rouge, Louisiana 70802

I am Klaus Meyer-Arendt, with Coastal Environments, Inc., a Baton Rouge based consulting firm that has been involved with coastal and wetland management since the early 1970s. Having done extensive work at both the state and parish level, we have recognized the wetland deterioration and shoreline erosion problem and have made extensive recommendations over the past several years. Unfortunately, efforts to restore disappearing wetlands and maintain a healthy barrier shoreline require large financial expenditures which are often beyond the means of local and parish governments. The State Act 41 (Coastal Environmental Protection Trust Fund) is the first serious commitment to preserving Louisiana's wetlands resources and maintaining the first line of defense against community-threatening hurricanes, and several pilot projects are slated for implementation.

I laud the Corps of Engineers for at last acknowledging the severity of the coastal erosion problem - a problem that, to a great extent, has been accelerated by the hand of man (eg. prevention of wetlands sedimentation via overbank topping by Mississippi River floodwaters, hydrologic modification and saltwater intrusion as a result of canal dredging, increased shore erosion due to jetty construction, and accelerated land loss due to hydrocarbon extraction processes.) Although the effects of large-scale natural processes may well be beyond our capabilities to reverse, we can respond to these processes in such a fashion that impacts are minimized.

A good case in point is right here in Cameron Parish. Based on research and fieldwork conducted in 1981 and 1982, I found shoreline erosion to have increased greatly at Constance Beach, Ocean View Beach, and Chaisson Subdivision since the highway revetments were laid at Peveto Beach in the early 1970s. In fact, the highest rates of shoreline erosion in southwest Louisiana (west of the Mermentau River mouth) occur in this area. Natural beach nourishment was formerly supplied by sands eroded from the beach ridge upon which the coastal highway was built. By placing rocks and gobi block mats along the shore we have robbed downdrift coastal reaches of part of their sand supply. Now T-groins are planned for the Peveto Beach revetments, and additional longshore sands will be prevented from arriving at the eroding recreational settlements. The point is, when we implement structural measures, we need to be aware of the consequences along a much broader expanse of coast. The introduction of sufficient quantities of sand to augment highway protection projects will help offset the increased threat to beachfront communities.

My name is Sherwood M. Gagliano. I am president of Coastal Environments, Inc., a Baton Rouge based applied science and planning firm. I have been professionally active in environmental science studies and planning in coastal Louisiana for about 25 years and my firm has been similarly active since its inception in 1972.

The Corps should be congratulated for formally recognizing the massive environmental problems that endanger coastal Louisiana, its people, economy and resources. The three study of finding reports concerning water supply, land loss and marsh creation, and shore and barrier island erosion circulated prior to this meeting are indeed historic documents. The reports seem to represent an important change in policy. Not only are the problems identified, but their link to federally funded and permitted activities, for which the Corps is largely responsible, is acknowledged. It is rare for any governmental agency to indulge in such self criticism. Colonel Lee and his staff deserve considerable credit for the disclosures in the reports.

Because of the historic nature of these reports, their wide distribution, their influence on policy and on the area in which we live, it is important that the record be kept accurate. At least two of the documents, (the one concerning land loss and marsh creation and the one concerning shore and barrier island erosion) give the impression that the problems and proposed solutions have been newly discovered as a result of the Corps study initiated in 1983. Indeed they may have been discovered by the Corps in 1983, but as a matter of fact these problems and solutions have been the subject of considerable study and public discussion for more than a dozen years. For those actively involved in such study and discussion, the excessive use of "we found," "we have identified," and "we have concluded" is inappropriate, particularly since many of the illustrations and sections of the reports are little more than redrawn versions and paraphrasing of the work of others. I offer this criticism, not to detract from the importance of the Corps findings, but rather to air a grievance that could fester into a painful wound that may hinder the kind of future cooperation that will be necessary to resolve the monumental problems of the coastal zone. Simply because the Corps proclaims that it has identified these problems and is investigating solutions does not mean that the solutions will be implemented and that the problems will be resolved.

As indicated in the reports, coastal Louisiana is in a serious condition of deterioration. This is clearly due to detrimental human impact on the Mississippi River Delta system, the natural system which occupies and sustains the area. The data indicate that this natural system may have already collapsed. It will never be restored to its former condition, nor is it likely that it can even be maintained in its present condition. The best that we can hope for is to reduce the present catastrophic rate of deterioration and stabilize remnants of the system. Even this holding action will cost billions of dollars. In other words we are faced with stabilizing and repairing damages. Nevertheless, even the remnants which can be salvaged are of immense national value. The alternative is to lose all values and gradually retreat from the area as it slowly sinks and erodes away.

An interesting question implicit in the reports is...who will pay for the work? It is implied that if the ratio of cost to benefits is favorable the various projects will be recommended to Congress for authorization and funding. It is also implicit that local sponsors and local cost sharing will be required. Much of the cost-benefit determination seems to hinge on the value of the marsh and other lands that are eroding and endangered. These values remain to be established. Perhaps a more appropriate approach to the same questions would be from the standpoint of damage restoration cost and who is responsible for the damages?

What is really under consideration is rebuilding and restructuring the Louisiana coastal zone for the future. It is important to recognize that local and state government in conjunction with the private landowners must play the prinicipal roles in determining the future configuration of the area and formulating a master plan for it. This process is now in progress in a number of the coastal parishes. The kinds of public works projects proposed in the Corps reports will be a necessary part of this rebuilding process, but must conform to the master plan.

The opportunity to comment on these reports is greatly appreciated. My comments are offered in the spirit of support and constructive criticism for a program that addresses critical problems of our area. I hope that we will be able to work together in identifying and implementing effective and acceptable solutions.

Attention: Regional Planning Branch
U.S. Army Corps of Engineers
New Orleans District,
P.O. Box 60267,
New Orleans, La. 70160.
Sept. 11 84

Dear Sirs:

As Concerned voting-right citizens of the lower Cameron area, Mrs. Louise Cole Civil Rights, Leader, Mother Nurse represented the Minority-affairs, NAACP & Cameron Community 100 plus. We are most of all grateful for Colonel Eugene S. Witherspoon appearance in Cameron at the Police-Jury Bldg. was well represented. The erosion problem is very severe, in the parish the road condition, highways especially Johnson-Bayou-Holley Beach is very very serious at the present time, valuable land is being eaten-up, eroded each year, the problem is not getting better but worst.

The resources, summer homes, Camps will have no domain if the problem or

Con't

Crisis isn't stopped or problem corrected.

I, Charles Zhivaga Cole, Law-Major is totally concerned about the serious problem in the lower Cameron Parish. The lives, health conditions of Cameron Parish is being victimized and threaten, land loss, Marsh Creation has been a serious factor for the last several years.

Let it go on record:

① [redacted] throughter investigation concerning serious road & land (erosion) problem.

② A workeable Solution that will help solve the crisis

③ Studies, experiments, projects to prevent further land loss

④ A frequent monitor, study conducted by the Corps Louisiana Coastal Area Study

Please keep us posted:

Address: Attn: Civil-Rights leader, Pres. NAACP

Mrs. Louise Cole, P.O. Box 109 Cameron La. 70631

or Charles Z. Cole (Youth Speaker) Mt. Nebo 2817½ Fitz. M.L. King Hwy

Lake Charles La. 70601

Tulane

Tulane Law School
Joseph Merrick Jones Hall
Tulane University
New Orleans, Louisiana 70118

Faculty

August 14, 1984

Colonel Robert C. Lee
District Engineer
U.S. Army Corps of Engineers
New Orleans District
P. O. Box 60267
New Orleans, Louisiana 70160

Re: Notice of Study Findings, Louisiana Coastal Area, Louisiana, Land Loss and Marsh Creation, Initial Evaluation Study

Dear Colonel Lee:

Thank you for a copy of the above-referenced Notice. As you know, I have done considerable research on the same subject, and continue to do more. I am writing to request information concerning two aspects of your Notice.

First, the Notice states that, "Constructing the 6,100 miles of navigation, drainage, and petroleum access canals in the coastal area has caused nearly 200,000 acres of the wetlands loss", Notice, p. 3. In light of the studies of Day, Turner and others on the impacts of canalization on the coastal zone (work which your Study could incorporate without injury), this figure seems quite conservative. I would hope that the Study does not view the impacts of a canal as limited to the original cut and its spoil banks; the phenomenon of canal-widening is well documented, as are the interior effects of salt water intrusion.. (The MRGO, for example. expanded widely since its construction, and opened up more than ,000 acres of marsh to Gulf waters.) Could you please provide the source for the 200,000 figure, or explain otherwise how it was derived?

Second, perhaps I have overlooked it but I see no discussion of the plugging and restoration of old canal cuts as a part of the solution. If this approach has been omitted, could you explain why?

Thank you for your attention to these requests. Your Study is important and overdue. I look forward with interest to its completion and recommendations.

Sincerely,

Oliver A. Houck
Professor of Law

OAH:je

Tulane

Tulane Law School
Joseph Merrick Jones Hall
Tulane University
New Orleans, Louisiana 70118

Faculty

September 28, 1984

Col. Eugene S. Witherspoon
U.S. Army Corps of Engineers
P. O. Box 60267
New Orleans, LA 70160

Dear Col. Witherspoon:

Thank you for yours of Sept. 11, and welcome to New Orleans.

Your letter responds to mine of August 14, 1984 concerning the impacts of oil, gas and navigation canals on the coastal zone as stated in your Initial Evaluation Study. These points:

1. Canal length. If, as stated, the 6,100 mile figure is based on a 1972 report and has not been updated, then it is quite in error and should not be used in your study. Most contemporary estimates of total canal length in the coastal zone increase the 6,000 figure to 10,000 miles or more. An accurate projection here is important because it identifies canals as a more active contributor to coastal erosion than had previously been thought. With this recognition comes the need for a solution addressed not only to the problem of the Mississippi levees, a problem addressed by proposals for freshwater diversion, but also to the problem of existing and future canals.

2. Canal impacts. The canal impacts also seem to be underestimated. As referenced in my earlier letter, experts at LSU's Center for Wetlands Resources attribute up to 89% of total erosion to the impact of canals. Whether the proper percentage is 50% or 89%, these are big impacts and will need to be addressed.

3. Remdies. You'll have to look far to find a stronger proponent of the Corps' freshwater diversion proposals. But freshwater diversion cannot do it all. Once the canals network is recognized as (1) huge and (2) impacting, it needs to be addressed in terms of remedy. Specifically:

(a) What more site-specific management proposals can be proposed to restore the thousands of miles already out there?

(b) What permit requirements can be imposed in the future to limit future damage?

These questions are ones your study will have to deal with, if it is not to be simply a redo of existing justifications for the freshwater diversion projects already decided upon.

I hope that these views are of assitance to you. If you have questions concerning them please do not hesitate to call me at (504) 865-5946.

Sincerely,

Oliver A. Houck
Professor of Law

OAH/rsr

cc: Peter Hawxhurst

STATEMENT PRESENTED BY:

CLAIRE V. CHAMPAGNE
BOX 52
THERIOT, LA. 70397

TO:

U.S. ARMY CORPS OF ENGINEERS
PUBLIC HEARING CONCERNING
LA. COASTAL AREA STUDY

WATER SUPPLY, LAND LOSS AND MARSH CREATION SHORE AREA BARRIER ISLAND EROSION

AUGUST 28, 1984 - 7:00p.m.

TERREBONNE PARISH COURTHOUSE
SCHOOL AND GOODE STREET
HOUMA, LOUISIANA

Tonight we address the most critical problem facing Terrebonne Parish. If this situation is not addressed properly and very soon, Terrebonne Parish will be nothing but a memory.

I own three (3) businesses and five (5) houses on Lower Bayou Dularge. This area was settled in 1839 by my great great grandparents.

We are the 5th generation to inhabit this land. Everything these 5 generations of people have, worked for is in jeopardy!

Try to picture if you can, 5 generations of families of blood, sweat and tears to clear this land, cultivate it, see the land yield its vegetables and fruit.

Let me tell you about one sad day in the history of our community. My grandfather after working all morning in the fields on a hot June day, suddenly became very ill and died. He was only 40 years old and left my grandmother with seven children. They buried him six feet under the land he loved so much. That same land fed my grandmother and her seven children through the work of their hands.

Today is a much sadder day!

That Beloved Land is six feet under water, Salt Water!

Please don't tell us we need more studies; so many studies have been done, so many millions of dollars have been spent studying this situation. So much time is slipping away while the studies continued.

Our situation is growing worse day by day.

The plant life that is present on this land today is not, I repeat, not the same plant life that was present 20 years or even 10 years ago.

Where I grew potatoes 10 years ago, the bullrushes and other marsh plants grow today.

There's a beautiful cypress swamp between Bayou Dularge and Dulac, it is now called "The Dying Swamp". The dead trees serve as a warning to all of us!

There's an eagle's nest behind my house in the swamp. It has been there many years. It is now surrounded by salt water.

You say by the year 2020 the problems facing Houma will be critical, I challenge that statement!

I am no expert. I am not a Scientist or an Engineer, I am 43 years old and what I have seen in the past 15 years proves to me that Houma does not have 35 years to prepare!

I am here to appeal to you, please no more studies. You know the problems, please do something to save our land, our homes, our businesses, our very way of life, our whole community is at stake! There are about 800 families south of Houma on Bayou Dularge alone. The move to save the barrier islands is a critical one, and I fully support your efforts! But our homes, our churches, our schools, our post offices, our communities south of Houma, deserve and demand your immediate attention.

While you study, the land under your feet is eroding.

1. In my humble opinion pumping sand is almost a useless measure, even with plant life one hurricane can wipe out millions of dollars of sand in one wave.

2. Spoils dredged from any channels should be utilized for the public good. (Example: for the rebuilding of marshes or for levees to prevent salt water intrusion). These spoils should not go to private individuals for resale.

Daming canals.

Plan 6 - Barrier to prevent salt water intrusion.

Locks on Houma Navigational Canal sounds like one of the best solutions.

Water supply needs - there are people better qualified than myself to address this problem.

BOLD NEW DIRECTION FOR HOUMA NAVIGATION CANAL

Recently, while staying overnight in New Iberia, I happened to read the local newspaper detailing their $500,000 state appropriation for the Port of Iberia. The appropriation will be used to create a barge loading/unloading facility to promote international and interstate trade. This prompted some mental exercises about what we could do to get our port off of the drawing board and lay some groundwork for new, diverse directions for our economy based around the Houma Navigation Canal. Therefore, this article/proposal is being written to provoke discussion as well as provoke action on our port, undoubtedly our most underutilized asset.

The first and most important problem one must address when analyzing our navigation canal is salt water intrusion, past, present, and future. My proposed solution is to construct a large lock just south of Cocodrie to prevent salt water intrusion. This lock could be used to raise the fresh water level in the Navigation Canal, causing fresh water to divert into some of the connecting bayous such as Grand Caillou and Bayou Sale.

To cost justify and pay for such a lock, the Navigation Canal needs to be deepened to 40-45 feet to allow for ocean freighter traffic. The user fees could be scaled to the size of the vessel to prevent undue hardship on smaller fishing vessels or the like (the smaller boats would have access via Bayou Sale or Grand Caillou). The deep water port could then be marketed as an alternative to New Orleans and Lake Charles, particularly in Trans-Modal shipping utilizing the inland waterways and barges. It is common knowledge that the Port of New Orleans is vulnerable to competition due to out moded material handling technology and uncompetitive labor costs and work practices. Our new port could embrace state of the art material handling technology and possibly remain non-union. Secondily, our port could attract process industries who need petroleum feedstocks, natural gas, and/or plently of fresh water in conjunction with deep water access to our inland waterways.

The third segment of this proposal is to provide our barrier islands with fill material. A rock jetty should be built from the lock out into the Gulf of Mexico, with cross accesses within Terrebonne Bay. Firstly, the jetty within the bay would reduce some of the dynamic action of the water that currently is eroding the North and South shore of Terrebonne Bay. Secondily, the rock jetty jutting out into the Gulf would protect the leeward side of the barrier islands. In conjunction with the rock jetty, a permanent pipeline would be laid along side of the jetty to the

barrier islands. The Corps of Engineers would determine how far north one would go with the pipeline before the fill is unacceptable. The pipeline would have flanged openings every few thousand feet so that the dredging operators in the channel can tie into the pipeline and move the material out to the barrier islands. At that point, a movable boom discharge line would be used to spot the fill material where it is needed. With a normal pipeline life of 20 years, we could have a permanent source of replacement material for our barrier islands while maintaining channel depth. Because of depressed activity in the natural gas market (the industry is centered around Houma) it is probable that a line could be built near costs in today's market.

The only environmental problem is disposing of the spoil material in the northern half of the canal. Here again, we propose building a second pipeline (or a continuam of the first) with flanged openings. The port commission could acquire approximately 100 acres (of minimal enviromental damage) and use as the spoil receptacle. Then, the port commsission could divide it into sections and sell the dirt to dirt contractors as it is similarly done today on a smaller scale. The revenue generated from the sale of this quality top soil would be used to offset some of the expenses of this operation.

In effect, the Naviagation Canal would be one big re-cycling machine, nourishing our barrier islands as well as preventing salt water intrusion. New industry would be created as well as user fees would be generated from the locks. It is my sincere belief that only a project centered around large scale economic benefits can pay for projects required to reverse the environmental damage done to lower Terrebonne Parish. A project of this scale would also lay the foundation for a prosperous economy for our children and their children.

The time for us to act on our deep water port in now. When the oil is gone; and Cocodrie is an island; and Dulac is the beach; and the shrimp and oyster industries severely depressed; and Houma has no fresh water; it will be too late. We must act now and boldly to protect our good earth.

D. Keith Rhea